2021 Guadalupe River Watershed Fisheries Monitoring

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Reports included:

2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Guadalupe River Watershed

- Appendix A: 2020 – 2021 Guadalupe River Watershed Stream Temperature Monitoring
- Appendix B: 2021 Guadalupe River Watershed Central California Coast Steelhead (*Oncorhynchus mykiss*) Condition Analysis

Guadalupe River Watershed *Oncorhynchus mykiss* 2020 – 2021 Migration Monitoring Using Passive Integrated Transponder Tags

- Appendix A: PIT Tag Master List

Guadalupe River 2020 – 2021 Adult Salmonid Migration Monitoring Using the Vaki Riverwatcher Passive Monitoring System at the Alamitos Drop Structure

- Appendix A: Example Silhouettes and Video Images

2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Guadalupe River Watershed

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Executive Summary

Valley Water has been conducting juvenile steelhead (*Oncorhynchus mykiss*) monitoring in Guadalupe River and Guadalupe Creek since 2004 as part of the downtown Guadalupe River Project. The monitoring was concluded in 2013, but Valley Water recommended the continuation and expansion of monitoring efforts to better understand *O. mykiss* numbers and distribution in the Guadalupe River Watershed. In 2013, the Guadalupe River Project's Adaptive Management Team (AMT) approved the recommendation (No. 136) to expand monitoring, and in 2018 proper permits were obtained.

In fall 2021, monitoring was conducted at 18 stations in the Guadalupe River Watershed, including stations in the Guadalupe River, Guadalupe Creek, Los Gatos Creek, Calero Creek, and Alamitos Creek. Due to extreme drought conditions and the presence of homeless encampments and associated risk of exposure to COVID-19, not all stations sampled in previous years were re-sampled in 2021. Multi-pass depletion backpack electrofishing was conducted at each station to determine the presence of *O. mykiss* as well as the composition of other fish species in the Guadalupe River Watershed. Thirty-three appropriately sized *O. mykiss* (≥ 65 mm) were tagged with Passive Integrated Transponder (PIT) tags to study their movement within the Guadalupe River Watershed.

Juvenile *O. mykiss* were documented in Alamitos, Calero, and Guadalupe Creeks during fall 2021 sampling, with 3 (0.02 *O. mykiss*/m), 28 (0.23 *O. mykiss*/m), and 6 (0.04 *O. mykiss*/m) individuals captured in each creek, respectively. No *O. mykiss* were detected in Los Gatos Creek or Guadalupe River. Based on the size range of fish collected, it can be deduced that multiple age classes were present and reproduction and successful summer rearing occurred.

Five species of native fish were captured within the Guadalupe River Watershed including riffle sculpin (*Cottus gulosus*), prickly sculpin (*Cottus asper*), Southern Coastal California roach (*Hesperoleucus venustus subditus*), Sacramento sucker (*Catostomus occidentalis*), and *O. mykiss.* Four species of non-native fish were observed amongst the five systems sampled, representing less than 5% of the total number of fish observed in 2021. These included mosquitofish (*Gambusia affinis*), largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), and tule perch (*Hysterocarpus traskii*). Los Gatos Creek and Alamitos Creek held the highest percentage of non-natives (37.5% and 13.0%, respectively).

This juvenile rearing monitoring is part of a continuing effort to better understand *O. mykiss* distribution and abundance in the Guadalupe River Watershed. This report contains the methods and results of the monitoring conducted in 2021 with an analysis of the data from 2004 to 2021.

Contents

Executive Summary i
1. Introduction 1
2. Methods 2
  2.1 Station Selection 2
  2.2 Sampling Methods 10
    Habitat Typing 10
    Electrofishing 12
    Fish Processing 13
  2.3 Data Analysis 14
3. Results and Discussion 15
  3.1 Guadalupe River 15
    GR001 15
    GR003 18
    GRBONUS 21
    Guadalupe River Discussion 22
  3.2 Guadalupe Creek 24
    GC003 24
    GC004 27
    GC005 30
    GC006 33
    Guadalupe Creek Discussion 35
  3.3 Los Gatos Creek 37
    LG003 38
    LGBONUS 39
    LG004 40
    Los Gatos Creek Discussion 42
  3.4 Alamitos Creek 43
    AC001 44
    AC002 45
    ACBONUS 46
    AC003 48
    AC004 49
    Alamitos Creek Discussion 51
  3.5 Calero Creek 53
    CC001 53
    CCBONUS 55
    CC002 56
    Calero Creek Discussion 58
4. Conclusion 60
5. References 67

Tables

Table 1. Habitat type classifications (Ode 2007). 11
Table 2. Percent cover of physical habitat features ocular estimate scale (Ode 2007). 11
Table 3. Substrate classes (Ode 2007). 12

Table 4. GR001 water quality data and ocular estimates of habitat complexity. 16
Table 5. Number of fish captured and population estimates at GR001. 17
Table 6. GR003 water quality data and ocular estimates of habitat complexity. 19
Table 7. Number of fish captured and population estimates at GR003. 20
Table 8. GRBONUS water quality data and ocular estimates of habitat complexity. 22
Table 9. Number of fish captured and population estimates at GRBONUS. 22
Table 10. GC003 water quality data and ocular estimates of habitat complexity. 25
Table 11. Number of fish captured and population estimates at station GC003.........................26
Table 12. GC004 water quality data and ocular estimates of habitat complexity. 28
Table 13. Number of fish captured and population estimates at station GC004.........................29
Table 14. GC005 water quality data and ocular estimates of habitat complexity. 31
Table 15. Number of fish captured and population estimates at station GC005.........................32
Table 16. GC006 water quality data and ocular estimates of habitat complexity. 33
Table 17. Number of fish captured and population estimates at station GC006.........................34
Table 18. LG003 water quality data and ocular estimates of habitat complexity. 38
Table 19. LGBONUS water quality data and ocular estimates of habitat complexity. 40
Table 20. Number of fish captured and population estimates at station LGBONUS. 40
Table 21. LG004 water quality data and ocular estimates of habitat complexity. 41
Table 22. Number of fish captured and population estimates at station LG004. 42
Table 23. Station AC001 water quality data and ocular estimates of habitat complexity. 44
Table 24. Number of fish captured and population estimates at station AC001. 45
Table 25. AC002 water quality data and ocular estimates of habitat complexity. 46
Table 26. Number of fish captured and population estimates at station AC002. 46
Table 27. ACBONUS water quality data and ocular estimates of habitat complexity. 47
Table 28. Number of fish captured and population estimates at station ACBONUS. 48
Table 29. AC003 water quality data and ocular estimates of habitat complexity. 49
Table 30. Number of fish captured and population estimates at station AC003. 49
Table 31. AC004 water quality data and ocular estimates of habitat complexity. 50
Table 32. Number of fish captured and population estimates at station AC004. 51
Table 33. CC001 water quality data and ocular estimates of habitat complexity. 54
Table 34. Number of fish captured and population estimates at station CC001. 55
Table 35. CCBONUS water quality data and ocular estimates of habitat complexity. 56
Table 36. Number of fish captured and population estimates at station CC003. 56
Table 37. CC002 water quality data and ocular estimates of habitat complexity. 57
Table 38. Number of fish captured and population estimates at station CC002. 58
Table 39. 2021 average density and median fork-length of O. mykiss captured in Alamitos, Calero, and Guadalupe Creeks. 61
Table 40. Total capture of fish per sub-watershed and percentage of non-native species. 64

Figures

Figure 1. Guadalupe River juvenile rearing monitoring stations. 5
Figure 2. Guadalupe Creek juvenile rearing monitoring stations. 6
Figure 3. Los Gatos Creek juvenile rearing monitoring stations. 7

Figure 4. Alamitos Creek juvenile rearing monitoring stations. 8
Figure 5. Calero Creek juvenile rearing monitoring stations. 9
Figure 6. Photos of station GR001 looking upstream (left) and looking downstream (right). 16
Figure 7. Station GR001 standardized O. mykiss capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station. 18
Figure 8. Photos of station GR003 looking upstream (left) and looking downstream (right). 19
Figure 9. Station GR003 standardized O. mykiss capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station. 20
Figure 10. Photos of station GRBONUS looking upstream (left) and looking downstream (right). 21
Figure 11. Photos of station GC003 looking upstream (left) and looking downstream (right). 25
Figure 12. Station GC003 standardized *O. mykiss* capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station. 27
Figure 13. Photos of station GC004 looking upstream (left) and looking downstream (right). 28
Figure 14. Station GC004 standardized O. mykiss capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station. 30
Figure 15. Photos of station GC005 looking upstream (left) and looking downstream (right). 31
Figure 16. Station GC005 standardized O. mykiss capture 2018-2021. Dashed line indicates the average density from 2018-2020 at this station. 32
Figure 17. Photos of station GC006 looking upstream (left) and looking downstream (right). 33
Figure 18. Station GC006 standardized O. mykiss capture 2018-2021. Dashed line indicates the average density from 2018-2020 at this station. 35
Figure 19. Guadalupe Creek 2021 O. mykiss fork-lengths. Measurements are binned in 10 mm increments. 36
Figure 20. Photos of station LG003 looking upstream (left) and looking downstream (right)......38
Figure 21. Photos of station LGBONUS looking upstream (left) and looking downstream (right). 39
Figure 22. Photos of station LG004 looking upstream (left) and looking downstream (right)......41
Figure 23. Photos of station AC001 looking upstream (left) and looking downstream (right). 44
Figure 24. Photos of station AC002 looking upstream (left) and looking downstream (right). 45
Figure 25. Photos of station ACBONUS looking upstream (left) and looking downstream (right). 47
Figure 26. Photos of station AC003 looking upstream (left) and looking downstream (right). 48
Figure 27. Photos of station AC004 looking upstream (left) and looking downstream (right). 50
Figure 28. 2018-2021 O. mykiss capture densities across all Alamitos Creek monitoring stations. Dashed line indicates the average density from 2018-2020. Note that ACBONUS densities cannot be directly compared between years since the station location changes each year...52
Figure 29. Photos of station CC001 looking upstream (left) and looking downstream (right). 54
Figure 30. Photos of station CCBONUS looking upstream (left) and looking downstream (right). 55
Figure 31. Photos of station CC002 looking upstream (left) and looking downstream (right). 57

Figure 32. 2018-2021 O. mykiss capture densities across all Calero Creek monitoring stations. Dashed line indicates the average density from 2018-2020. Note that CC003 was not sampled in 2021 and CCBONUS was only sampled in 2021. 59
Figure 33. Calero Creek 2021 O. mykiss fork-lengths. Measurements are binned in 10 mm increments. 60
Figure 34. Boxplots (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges, outlying points beyond whiskers, and mean (x)) of O. mykiss size distribution (fork-length) for Alamitos, Calero, and Guadalupe Creek sub-watersheds in 2021..62
Figure 35. Non-native fish species composition per sub-watershed. 63

Appendices

Appendix A: 2020-2021 Guadalupe River Watershed Stream Temperature Monitoring
Appendix B: 2021 Guadalupe River Watershed Central California Coast Steelhead (*Oncorhynchus mykiss*) Condition Analysis

1. Introduction

The United States Army Corps of Engineers (USACE), in partnership with Valley Water, constructed both the Guadalupe River Project (Downtown Project) and Upper Guadalupe River Project (UGRP) on the Guadalupe River mainstem. These projects together extended from approximately Norman Y. Mineta San Jose International Airport to Blossom Hill Road to protect downtown San Jose from Guadalupe River flooding. To offset the impacts of constructing the Downtown Project, the Guadalupe River Project Mitigation and Monitoring Plan (Downtown Project MMP) specified that a variety of mitigation be undertaken, including restoration of Guadalupe Creek from approximately Almaden Expressway to Masson Dam (Corps 2001a). The Downtown Project MMP also described the monitoring methods and measurable objectives for determining the success of mitigation. This included 10 years of monitoring for juvenile rearing of federally threatened Central California Coast steelhead (*Oncorhynchus mykiss*) at 12 stations in the mainstem Guadalupe River and 8 stations within Guadalupe Creek to demonstrate whether the associated measurable objective was being met: “The Guadalupe River must continue to support juvenile rearing at a level that is consistent with pre-project conditions and environmental conditions not affected by the Guadalupe River Project” (Jones and Stokes 2004).

Valley Water conducted the required juvenile rearing monitoring from 2004 to 2013, and the measurable objective was met in each year. Instead of ending the monitoring, Valley Water recommended continuing and expanding it to better understand juvenile *O. mykiss* distribution and densities, collect genetic information, and implement an *O. mykiss* tracking study using Passive Integrated Transponder (PIT) tags, as well as to document the composition of other fish species in the watershed. In 2013, the Downtown Project Adaptive Management Team (Guadalupe AMT) approved the recommendation (No. 136) to continue juvenile rearing monitoring at five of the previous monitoring stations on the Guadalupe River and expand the monitoring to 15 stations elsewhere in the watershed. However, the Downtown Project permits did not authorize juvenile rearing monitoring at additional stations. From 2013 to 2017 (with the exception of 2014), juvenile rearing monitoring continued at the original permitted stations (as flow conditions allowed) on Guadalupe River and Guadalupe Creek, while the permits for monitoring at additional stations were acquired. Ultimately, expanded monitoring in the Guadalupe River Watershed was authorized under a National Marine Fisheries Service (NMFS) Section 10(a)1(A) recovery permit and a California Department of Fish and Wildlife (CDFW) Scientific Collecting Permit. In 2018, Valley Water expanded the juvenile rearing monitoring to include areas outside of the Guadalupe River Project reaches as well as into Los Gatos Creek, Alamitos Creek, and Calero Creek. In 2021, data collection occurred under NMFS Section 10(a)1(A) Recovery Permit number 16417-3M and CDFW Scientific Collecting Permit, Specific Use Permit number S-191480002-21124-001.

For the Guadalupe River Projects, juvenile rearing monitoring results were reported to the Guadalupe AMT in the annual Mitigation Monitoring Report (MMR). Detailed information on the sampling conducted between 2004 and 2017 can be found in the 2017 Guadalupe River Mitigation and Monitoring Report (Valley Water and Stillwater Sciences 2018). Beginning in Water Year (WY) 2018, monitoring results were reported in a stand-alone document to facilitate distribution to FAHCE stakeholders as well as the Guadalupe River Projects' AMT. The 2021 results will continue in this manner.

2. Methods

2.1 Station Selection

A total of 18 stations within the Guadalupe River Watershed were sampled between October 18 and November 17, 2021. These stations included a subset of the stations where monitoring was conducted in 2004 through 2017, as well as the expanded sites selected in 2018 to provide continuity from the previous monitoring effort on Guadalupe River and Guadalupe Creek and maintain a long-term dataset. Stations GR001 to GR004 and GC001 to GC004, are the subset of stations within this report that have been consistently sampled since 2004. The new stations where monitoring began in 2018 were selected using random stratified sampling, and details associated with site selection can be found in the 2018 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Guadalupe River Watershed report (Valley Water 2019). In 2020, low flow conditions and homeless encampments prevented sampling at some stations which had been sampled in previous monitoring seasons, thus one area of interest was selected on Alamitos Creek and one on Guadalupe River in order to increase the sample size. Similarly, in 2021, sampling was impeded at a number of stations and alternatives were selected on Alamitos Creek, Calero Creek, and Los Gatos Creek. Alternative monitoring sites were selected by spot-checking areas of the streams where there was connective flow and safe access conditions. Deciding factors for selecting an alternative site included environmental conditions, safety concerns, and the presence of at least two habitat types within an approximately 40 m stretch.

In 2021, three stations were sampled on Guadalupe River (Figure 1). Two of these stations have been sampled since 2004 (GR001 and GR003). Station GR002 was unable to be sampled this year due to the presence of a large homeless encampment posing health and safety concerns. Station GRBONUS (at Skyport Drive, downstream of station GR001) was added in 2020 and sampled again in 2021 to increase the number of stations sampled on Guadalupe River since four of the repeatedly sampled stations were unsampleable. Stations located upstream of the Los Gatos Creek confluence (GR004, GR005, and GR006) were unable to be sampled this year due to extreme drought conditions causing GR004 and GR006 to be completely dry and GR005 to be an isolated pool.

Four stations were sampled on Guadalupe Creek (GC003 – GC006), all of which were previously sampled from 2018 to 2020 (Figure 2). GC002 was unable to be sampled this year as the station was an isolated pool, and GC001 was also unsampleable because the site was dry.

Three stations were sampled on Los Gatos Creek, two of which were sampled from 2018 to 2020 (LG003 and LG004), and one that was added this year to increase the number of sampling stations (LGBONUS; Figure 3). LG001 and LG002 were unable to be sampled this year due to homeless encampments posing health and safety concerns.

On Alamitos Creek, all four stations sampled from 2018 to 2020 were resampled, as well as an additional rotating station (ACBONUS; Figure 4). The location of this additional site will change on a yearly basis and is primarily used to increase numbers of captured *O. mykiss* for PIT tag injection. Therefore, yearly comparisons will not occur for this rotating station. This year, the additional site was located downstream of AC003.

Sampling on Calero Creek occurred at three stations, two of which were previously sampled from 2018 to 2020 (CC001 and CC002), and one that was added this year to increase the number of sampling stations (CCBONUS; Figure 5). CC003 was unable to be sampled this year as it was an isolated pool.

Valley Water also operates temperature monitoring stations within the study areas of the Guadalupe River and Guadalupe, Los Gatos, Alamitos, and Calero Creeks to provide continuous monitoring of habitat conditions and help inform the timing of juvenile rearing sampling (permits require that *O. mykiss* sampling not occur in waters >18°C). Details regarding stream temperature monitoring are provided in Appendix A.

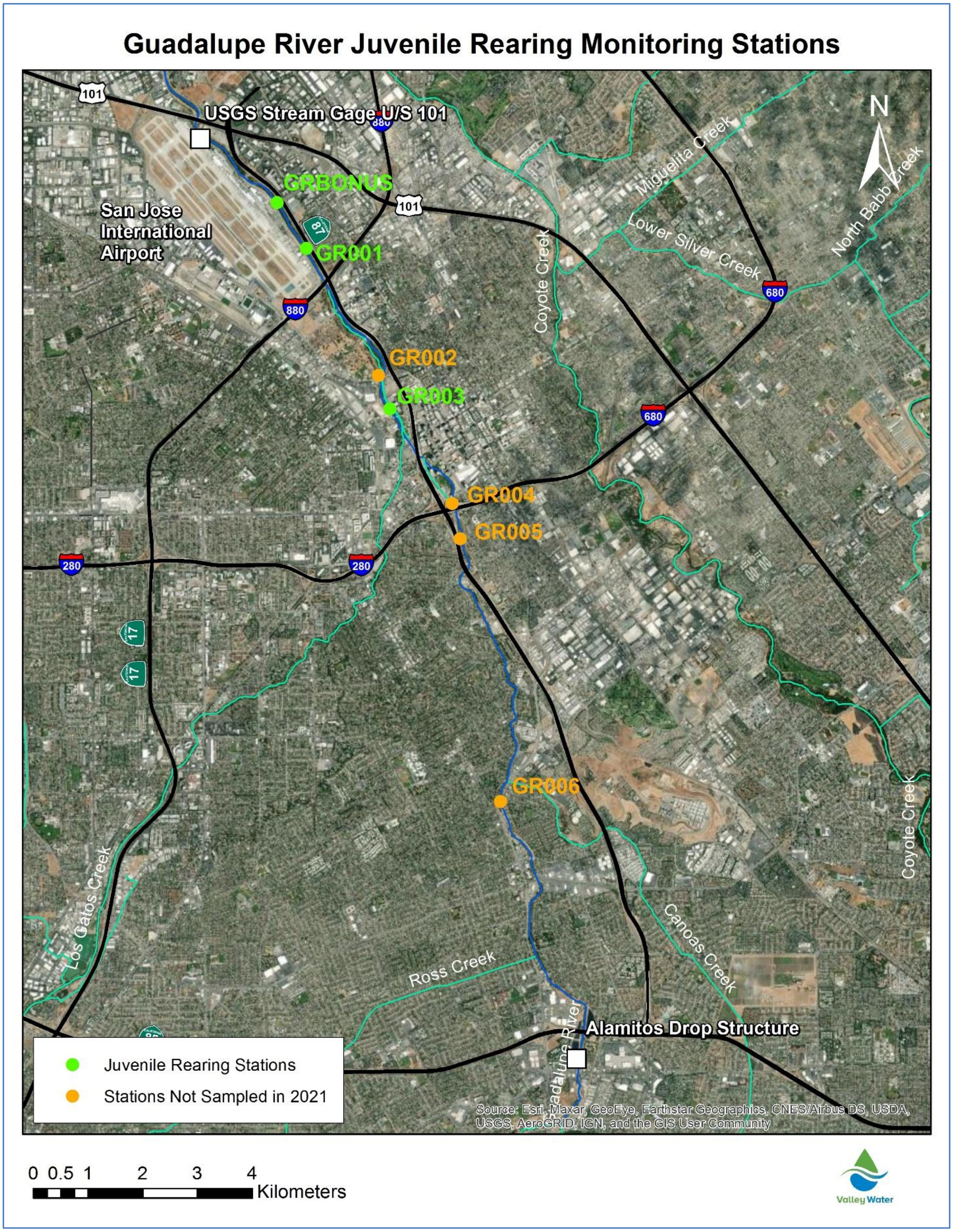
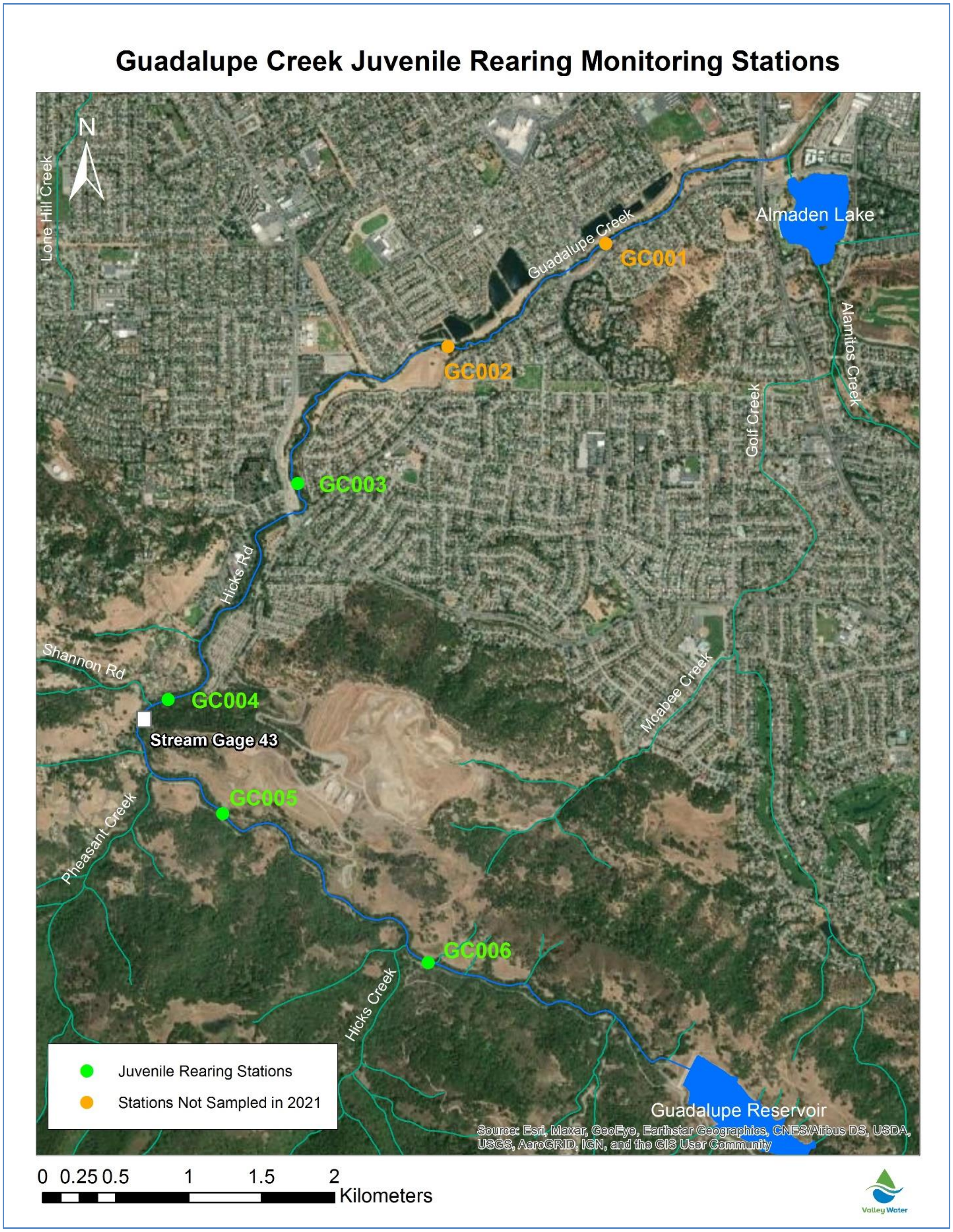
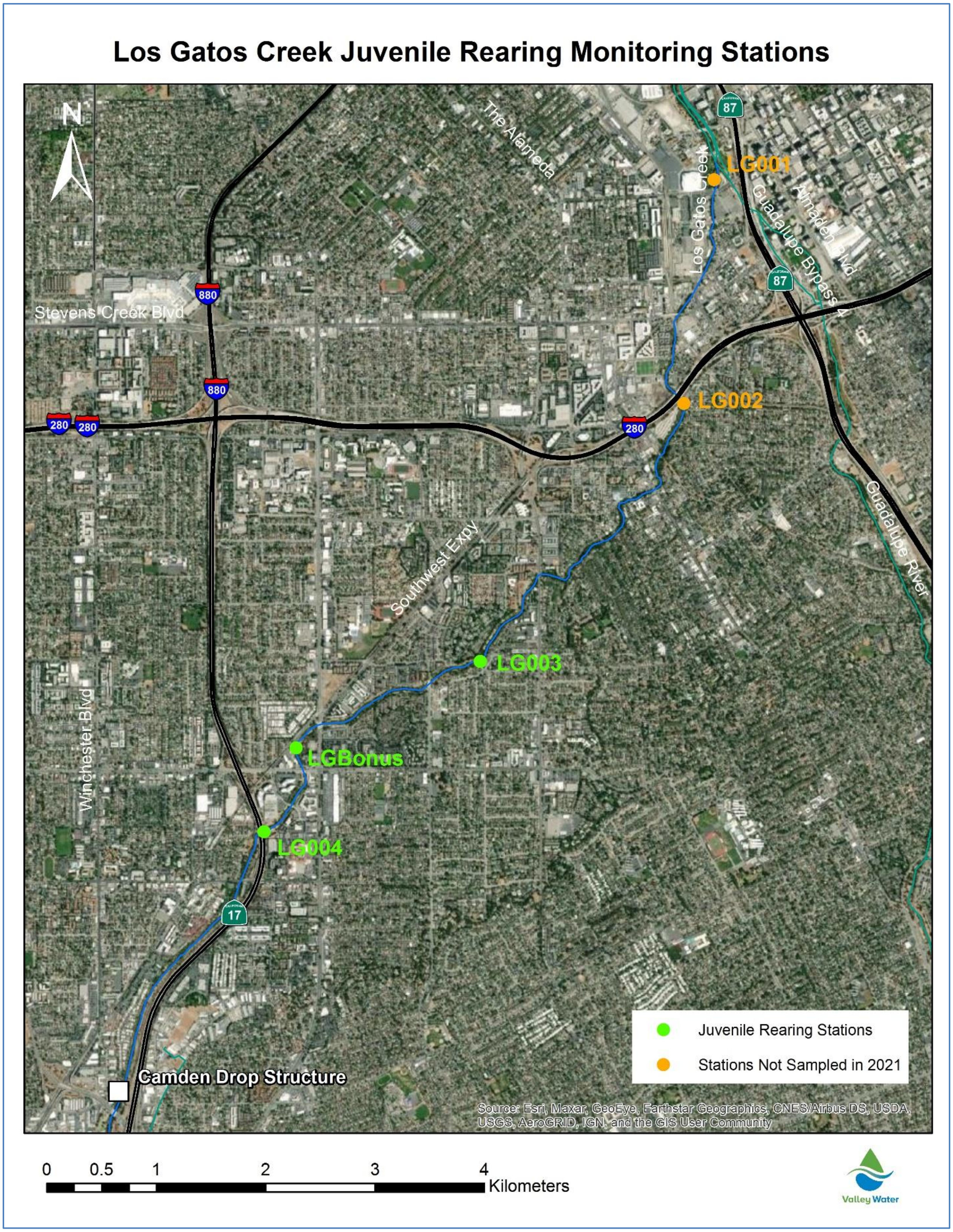

Guadalupe River Juvenile Rearing Monitoring Stations
USGS Stream Gage U/S 101
GRBONUS
San Jose International Airport
GR001
GR002
GR003
GR004
GR005
GR006
Miguelita Creek
North Babb Creek
Lower Silver Creek
Coyote Creek
Los Gatos Creek
Ross Creek
Canoas Creek
Guadalupe River
Alamitos Drop Structure
101
880
87
680
280
17
N
● Juvenile Rearing Stations
● Stations Not Sampled in 2021
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.5 1 2 3 4
Kilometers
Valley Water

Figure 1. Guadalupe River juvenile rearing monitoring stations.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 2. Guadalupe Creek juvenile rearing monitoring stations.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3. Los Gatos Creek juvenile rearing monitoring stations.

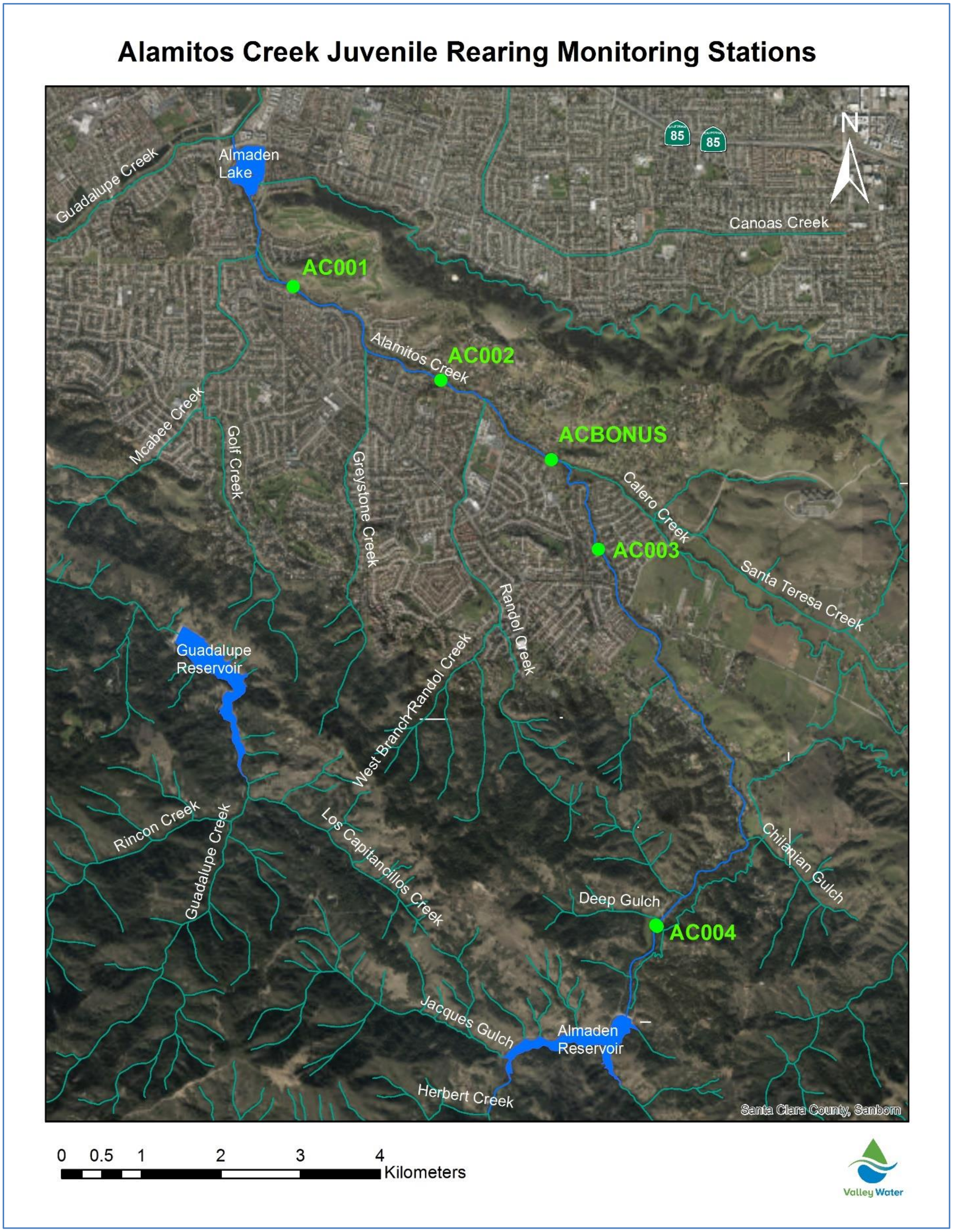

Alamitos Creek Juvenile Rearing Monitoring Stations

Figure 4. Alamitos Creek juvenile rearing monitoring stations.

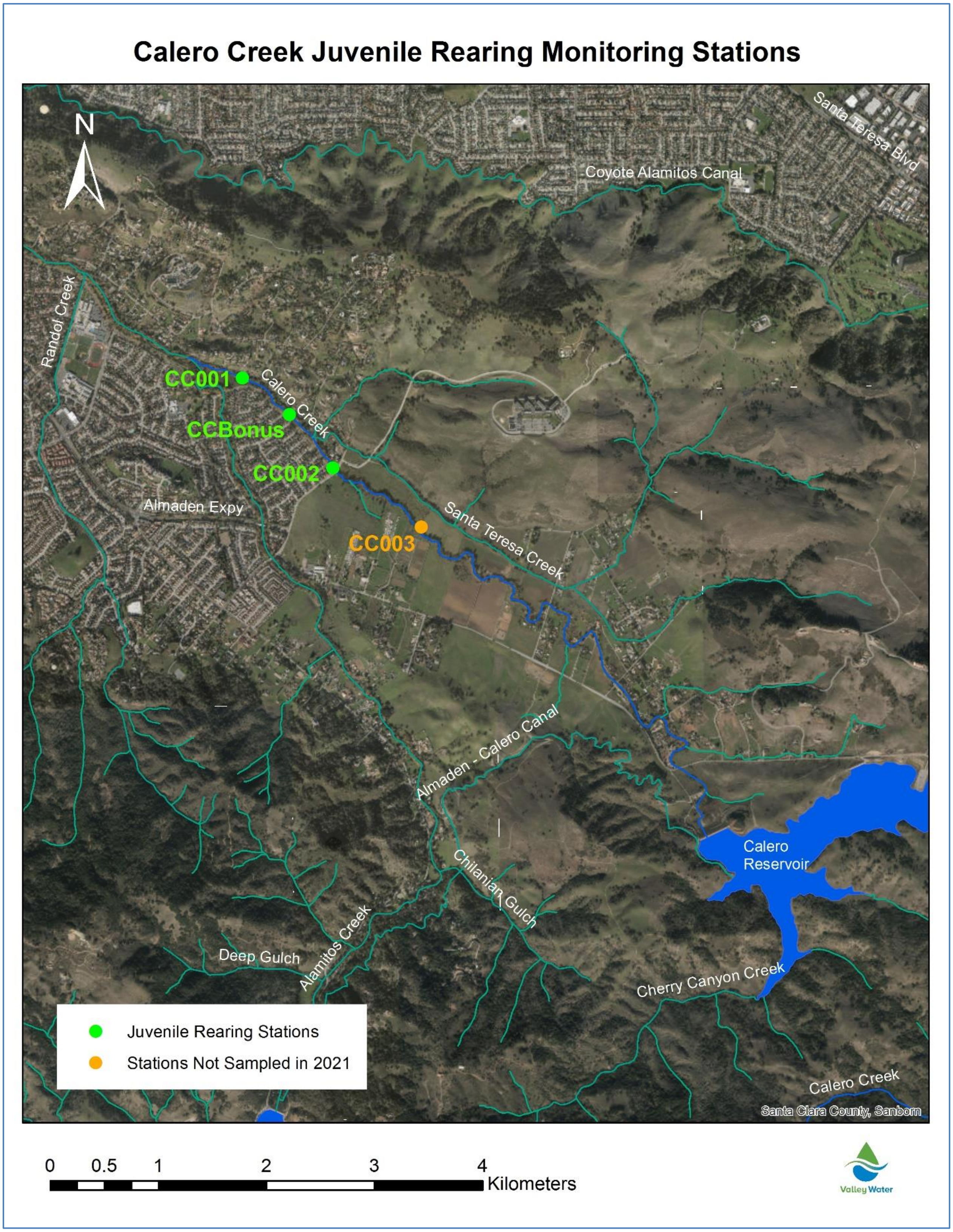


Figure 5. Calero Creek juvenile rearing monitoring stations.

2.2 Sampling Methods

Each monitoring station ranged between 38 and 48 m in length. The target length was 40 m, but deviations in length occurred based on either safety concerns, the ability to install and secure block nets, or to avoid areas where electrofishing could not be conducted effectively (e.g., water too deep). Each station included at least two distinct habitat types, which are described below. Multi-pass depletion backpack electrofishing (Johnson et al. 2007) was used at every monitoring station. This method allowed for consistency with previous juvenile rearing monitoring methods, the extrapolation of population estimates, and the sampling of a variety of habitat types.

Habitat Typing

Each monitoring station was habitat-typed following Ode (2007), using the classifications described in Table 1 as a guideline. Average wetted width and depth were estimated and the presence of any anthropogenic influences (bridge, dam, etc.) was noted. Prior to the start of sampling, ambient conditions (weather) were recorded and water quality parameters (dissolved oxygen, conductivity, turbidity, and temperature) were collected within each sampling station. Ocular estimates of percent cover of macrophytes/emergent vegetation, boulders, woody debris, undercut banks, overhanging vegetation, submerged roots (live and dead), and artificial structures were recorded for each monitoring station (Table 2; Ode 2007). Each habitat feature was ranked on a scale of 0 to 4, described in Table 2, with 0 being absent and 4 being a very heavy presence. Primary and secondary substrate types were determined based upon ocular estimates (Table 3; Ode 2007).

Table 1. Habitat type classifications (Ode 2007).

Habitat Type	Description
Cascades	Short, high gradient drop in streambed elevation often accompanied by boulders and considerable turbulence.
Falls	High gradient drop in elevation of the streambed associated with an abrupt change in the bedrock.
Rapids	Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles.
Riffles	Shallow sections where the water flows over coarse streambed particles that create mild to moderate surface turbulence.
Step-Run	A series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope.
Runs	Sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool.
Glides	A section of stream with little or no turbulence, but faster velocity than pools.
Pool	A reach of stream that is characterized by deep, low-velocity water and a smooth surface.

Table 2. Percent cover of physical habitat features ocular estimate scale (Ode 2007).

Scale	0	1	2	3	4
Percent Coverage	0%	<10%	10-40%	40-75%	>75%
Descriptor	Absent	Sparse	Moderate	Heavy	Very Heavy

Table 3. Substrate classes (Ode 2007).

Particle Size	Size Category
Boulder	> 250 mm
Cobble	64-250 mm
Gravel	2.0-64 mm
Sand	<2.0 mm (gritty texture)
Silt/Clay	Not gritty
Bedrock	No individual particles

Electrofishing

Block nets were installed at both the upstream and downstream ends of each sampling station to keep fish from immigrating into or emigrating out of the reaches. Block nets were secured with rebar and spreaders to hold the nets in place and keep the top of the nets above water. Large rocks were used to add extra security to the lead line and keep the bottom of the net flush with the channel bottom. Electrofishing then commenced from down- to upstream and laterally across the channel to ensure all wetted portions of the reach were sampled. Smith-Root® LR24 Backpack Electrofishing Units were used at all monitoring stations. Johnson et al. (2007) recommends that when portions of a creek exceed 7.0 m in width, two electrofishers be deployed to provide adequate coverage of the channel. Therefore, two electrofishers were used at all sampling stations on the Guadalupe River, but only one electrofisher was warranted on Alamitos, Calero, Guadalupe, and Los Gatos Creeks. The LR24 quick setup option was used to establish the initial power and waveform settings, and the output was verified with conductivity readings and manually adjusted as appropriate. Electrofishers were run using direct current at a frequency of 30 Hz, duty cycle of 12%, and voltage that ranged between 140 and 200 depending on field site conductivity. Each electrofisher operator was flanked by two netters. Verbal communication and spatial awareness were used to ensure the entire width of the stream was covered. Triple-pass depletion electrofishing methods were deployed at all stations unless no fish were captured on both the first and second pass, in which case a third pass was not conducted. All fish captured were held in dark colored 5-gallon buckets or live cars during each electrofishing pass prior to processing.

Fish Processing

Fish were held in aerated, dark-colored 5-gallon buckets during processing. Length measurements were recorded to the nearest millimeter at the fork of the tail (fork-length). For each pass, up to 30 individuals of each species were measured, and all additional individuals of that species were counted for a total number. All *O. mykiss* were measured regardless of number caught in a pass. Weights were recorded for *O. mykiss* to the nearest tenth of a gram using an OHAUS Navigator™ NVT22001 portable balance.

Carbon dioxide (CO_2) was administered to *O. mykiss* using Alka-Seltzer® Gold placed in a bucket of stream water in doses sufficient to induce light narcosis (1 tablet per 2.5 liters of stream water). *O. mykiss* were exposed to the anesthesia for no more than five minutes. *O. mykiss* were observed for listing, and upon listing were removed from the anesthetizing solution, weighed, measured, fin-clipped for a genetic sample, scanned to determine whether a PIT tag was present, and PIT tagged if large enough (≥ 65 mm fork-length) and the individual had not been previously tagged.

Fin clips (1-2 mm^2) were taken from the caudal fin for genetic analysis of all *O. mykiss*. Medical grade scissors used to collect the clips were sterilized between each use with an alcohol dilution with a final concentration of 60-80% isopropyl. Tissue samples were placed on sterile chromatography paper and put in a labeled envelope denoting the field specimen number, species, stream, sample station ID, date, fork-length, and weight. All tissue samples collected will be sent to the NMFS Southwest Fisheries Science Center for analysis once an adequate sample size has been collected.

All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 1999) by staff trained in the procedure. All *O. mykiss* 65 mm in fork-length or greater, and that had not been previously tagged, received a PIT tag.

Biomark® single-use preloaded needles and tagging guns (12 mm tags) and hand inserted plunger injectors (23 mm tags) were used in the tagging process. *O. mykiss* with fork-lengths ranging from 65 mm to 149 mm received 12 mm half-duplex PIT tags, and *O. mykiss* with fork-lengths of 150 mm or greater received 23 mm tags[1]. All PIT tag numbers and associated biological data for each fish tagged by Valley Water can be found in the Guadalupe River Watershed PIT tag monitoring report (Valley Water 2022).

Once processing was completed, all fish were transferred to an in-channel live car for recovery. The live car was placed outside of the sampling reach and outside of the field of current from the electrofisher in an area with flow, shade, and low relative turbidity from the time processing ended until the sampling event was complete to allow fish time to recover and to prevent processed fish from re-entering the sampling reach. All fish were released after the final pass.

2.3 Data Analysis

MicroFish 3.0 was used to calculate population estimates for each station using a maximum-likelihood iterative process (MLIP); the associated standard errors and 95% confidence intervals (CI) are reported herein. This method uses the number of fish captured (n) and the difference in capture between electrofishing passes (i.e., depletion rate) to calculate an estimate of individuals likely to have been present but not captured, thus generating a population estimate (N) for each species for each station. Population estimates are restricted to the sampled areas and are only an index of the overall population. If the number of a particular species was too low (i.e., only one fish was captured) or all individuals of a particular species were captured on the first pass (with no individuals of that species captured on subsequent passes), then a MLIP population estimate could not be produced. If the lower confidence interval was less than the total catch it was set equal to total catch, as it is certain at least that many fish were present in the sampling reach. These calculations assume: 1) fish emigration and immigration were prevented by the installation of upstream and downstream block nets, 2) shocking efficiency did not change between passes, 3) staff did not become more efficient at using the equipment, and 4) fish did not learn to avoid the electrical field between passes. Because sampling reach lengths may vary by station or by year, results have been standardized to catch per unit effort (number of fish per meter) to enable comparisons of the long-term dataset.

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[1] The permits allow for fish greater than 100 mm to be tagged with 23 mm tags, but to be conservative with the fishes' welfare, Valley Water increased the minimum size to 150 mm.

3. Results and Discussion

3.1 Guadalupe River

Sampling occurred at three stations on Guadalupe River on November 17, 2021. The weather was sunny and clear with no precipitation. Flows at the United States Geological Survey (USGS) stream gage upstream of Highway 101 (USGS #11169025), which provides the best representation of the sampled locations (juvenile rearing stations GR001, GR003, and GRBONUS), were approximately 14.0 cubic feet per second (cfs).

GR001

GR001 has been sampled annually during the 2004 to 2020 monitoring effort (with the exception of no sampling occurring in 2014). This station is low gradient. A dense riparian corridor is present (Figure 6), but the channel is situated between two levees and urban development. The monitoring station was 38.0 m in length with an average wetted width of 6.0 m and an average depth of 0.5 m. Two habitat types were present within the station: riffle and glide. Riffle habitat made up 63% of the sampling area, with the glide contributing 37%. The primary substrate was gravel with a secondary substrate of silt. Water quality and habitat complexity at the time of sampling are summarized in Table 4.

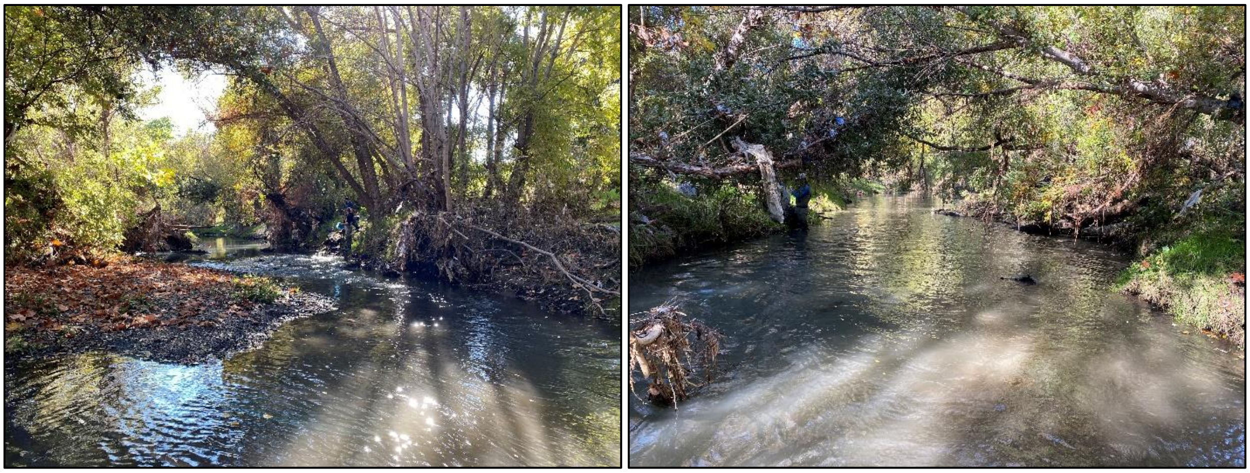

Figure 6. Photos of station GR001 looking upstream (left) and looking downstream (right).

Table 4. GR001 water quality data and ocular estimates of habitat complexity.

<table>
<tr><th colspan="7">Water Quality</th></tr>
<tr><th colspan="2">Conductivity
(µS/cm)</th><th colspan="2">Temperature
(°C)</th><th colspan="2">Dissolved Oxygen
(mg/L)</th><th>Turbidity
(NTU)</th></tr>
<tr><td colspan="2">1070</td><td colspan="2">16.29</td><td colspan="2">7.47</td><td>20.10</td></tr>
<tr><th colspan="7">Habitat Complexity Scoring</th></tr>
<tr><th>Macrophytes/Emergent Vegetation</th><th>Boulders</th><th>Woody Debris</th><th>Undercut Banks</th><th>Overhanging Vegetation</th><th>Roots</th><th>Artificial Structures</th></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td><td>3</td><td>1</td><td>1</td></tr>
</table>

Fish captured and associated population estimates are summarized in Table 5. Five species of fish were captured: prickly sculpin (*Cottus asper*), Southern Coastal California (SCC) roach (*Hesperoleucus venustus subditus*), Sacramento sucker (*Catostomus occidentalis*), mosquitofish (*Gambusia affinis*), and green sunfish (*Lepomis cyanellus*). No *O. mykiss* were captured.

Table 5. Number of fish captured and population estimates at GR001.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	9	9	0.46	9-10
Green sunfish	No	1	-	-	-
Mosquitofish	No	2	2	0.38	2-7
Prickly sculpin	Yes	11	11	1.02	11-13
Sacramento sucker	Yes	12	12	0.20	12-12

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Native fish, including SCC roach, prickly sculpin, and Sacramento sucker, made up most of the fish captured at station GR001, with Sacramento sucker being the most abundant species (n=12). For all species observed, the MLIP did not indicate that the number of fish present in the sampling reach was higher than the number of fish captured.

Station GR001 has 17 years of comparable data (no sampling occurred in 2014) between 2004 and 2021, shown in Figure 7. Historically, this station has had low production of *O. mykiss*. Of the 17 years of sampling data, *O. mykiss* were only collected in four of the years and have not been observed since 2012. The highest capture rate occurred in 2005 at 0.10 *O. mykiss*/m, and the average *O. mykiss* capture rate from 2004 to 2020 is 0.01 *O. mykiss*/m. These results indicate that *O. mykiss* occurrence in the downstream portion of the Guadalupe River is very low and inconsistent, and that potentially the population has not recovered since the severe drought conditions that occurred from 2014 to 2016.

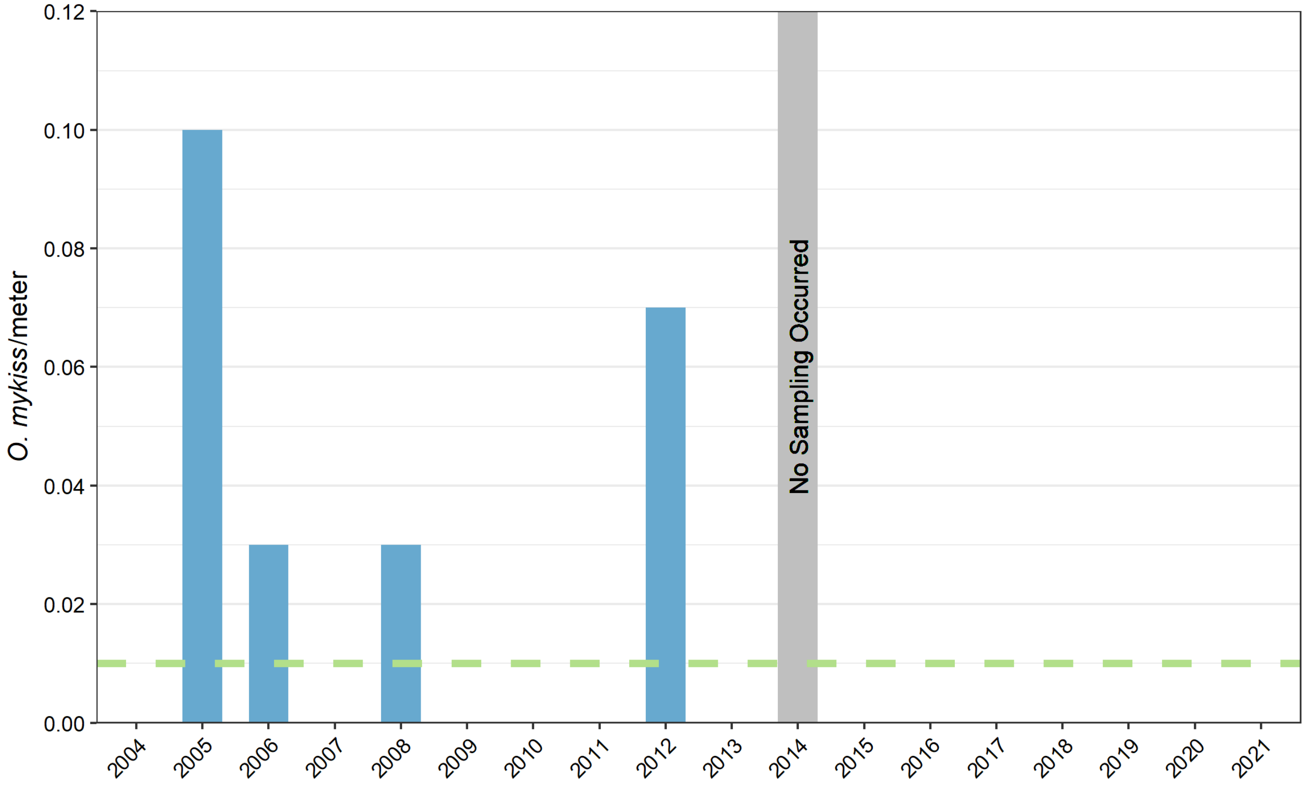

Figure 7. Station GR001 standardized *O. mykiss* capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station.

GR003

GR003 has been sampled annually from 2004 to 2020 (with the exception of 2014-2015). This sampling station includes the St. John Street Passage Remediation Project area, which created riffle habitat and anchored large woody debris in the channel. A portion of the station was under the St. John Street Bridge. The monitoring station was 40 m in length with an average wetted width of 7.0 m and an average depth of 0.15 m. Three habitat types were present within the station: riffle, run, and glide (Figure 8). The station was comprised of 65% riffle, 15% run, and 20% glide. The primary substrate was boulders with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity are included in Table 6.

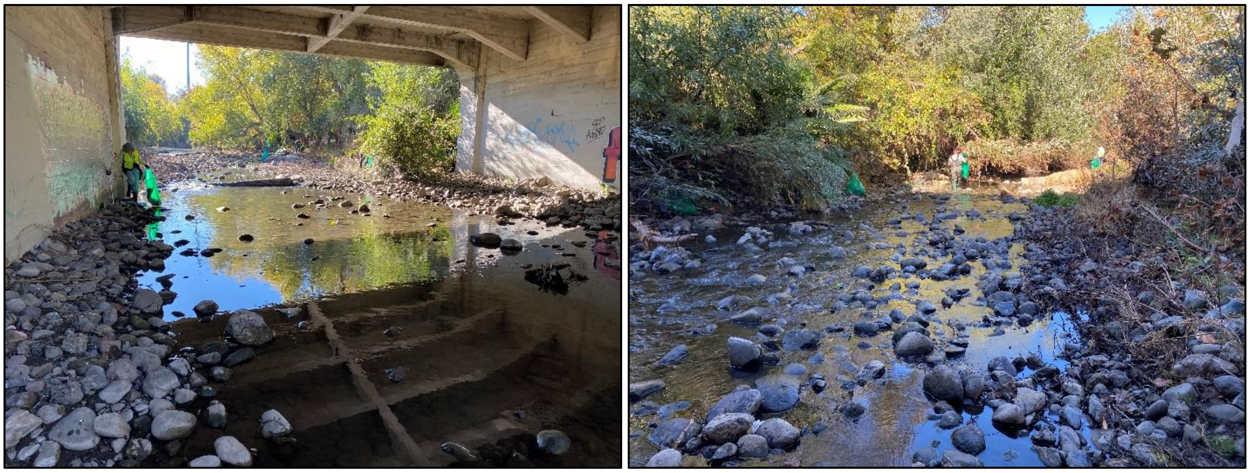

Figure 8. Photos of station GR003 looking upstream (left) and looking downstream (right).

Table 6. GR003 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
1180	14.82	9.50	39.10

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	3	1	0	1	0	2

Three species of fish, all native, were captured at GR003: SCC roach, prickly sculpin, and Sacramento sucker. The most abundant species encountered was SCC roach (n=24). No *O. mykiss* were captured. Fish captured and associated population estimates are summarized in Table 7. The MLIP indicated that the number of SCC roach and Sacramento sucker present in the sampling reach was likely higher than the number that were captured. In contrast, the population estimate for prickly sculpin was equal to the number that were observed.

Table 7. Number of fish captured and population estimates at GR003.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	24	29	6.01	24-41
Prickly sculpin	Yes	2	2	0.00	2-2
Sacramento sucker	Yes	19	20	1.90	19-24

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Station GR003 has 16 years of comparable data (no sampling occurred in 2014 or 2015). Figure 9 shows the standardized capture of *O. mykiss* between 2004 and 2021. Of the 16 years of data, *O. mykiss* were collected in eight of the years sampled and the highest density was observed in 2012 at 0.43 *O. mykiss*/m. The average *O. mykiss* density based on the 2004 to 2020 dataset for this station is 0.09 *O. mykiss*/m.

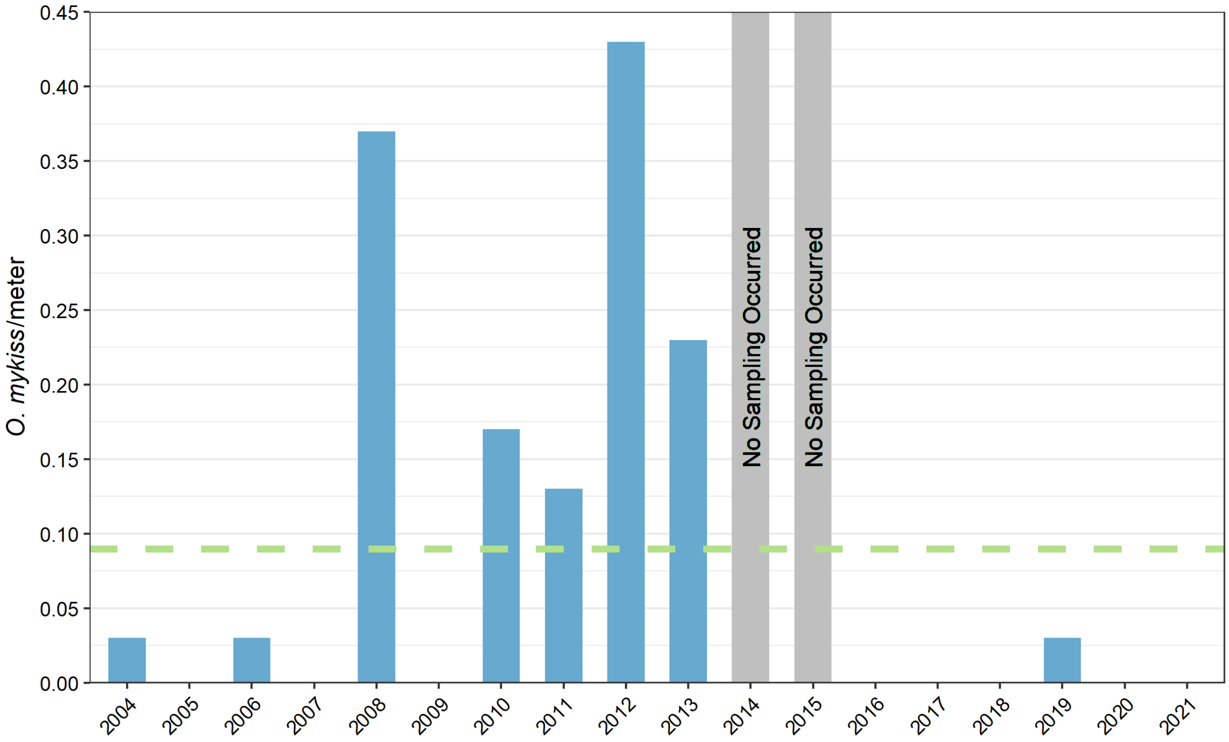

Figure 9. Station GR003 standardized *O. mykiss* capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station.

GRBONUS

GRBONUS was a new sampling station in 2020 located near Skyport Drive. This site was added due to the inability to sample most of the other previously sampled sites on the Guadalupe River mainstem and was sampled again in 2021 due to similar circumstances. The river was spot-checked between GR001 and GR003 and no suitable sites were available for sampling due to deep pools and/or health and safety concerns. This location was the next available site with suitable habitat and was the most downstream station sampled on the Guadalupe River. The monitoring station was 40 m in length with an average wetted width of 5.5 m and an average depth of 0.2 m. Habitat within the station was 30% riffle, 63% run, and 7% pool (Figure 10). The primary substrate was gravel with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 8.

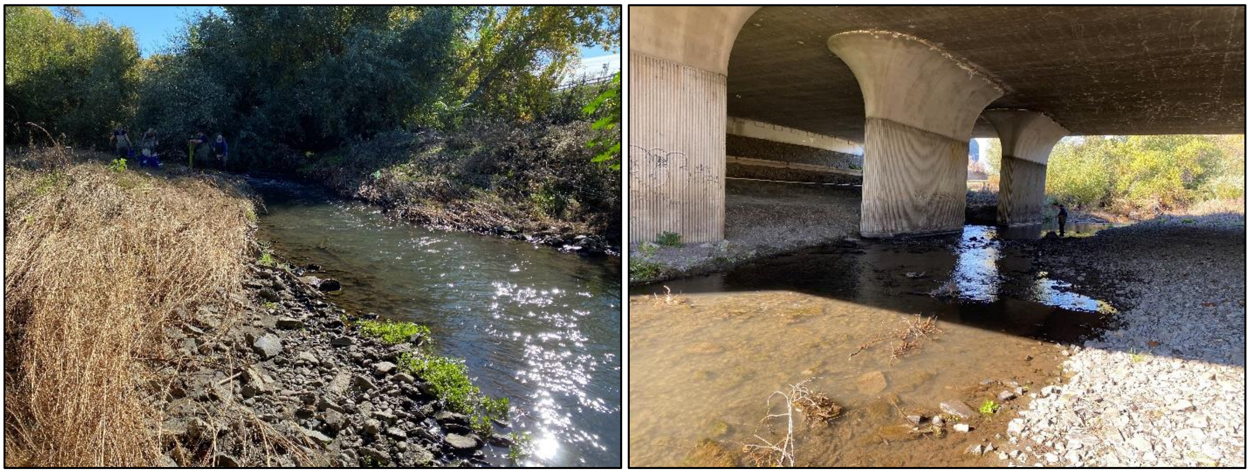

Figure 10. Photos of station GRBONUS looking upstream (left) and looking downstream (right).

Table 8. GRBONUS water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
1090	16.73	7.26	33.60

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
3	1	0	0	0	0	2

Two species of fish were captured and both were native: prickly sculpin and Sacramento sucker. The most abundant species encountered was prickly sculpin (n=17), and no *O. mykiss* were captured at this monitoring station. Fish captured and associated population estimates are summarized in Table 9. The MLIP did not indicate the calculated population estimate was higher than what was observed.

Table 9. Number of fish captured and population estimates at GRBONUS.

Species	Native	n	N	SE	95% CI
Prickly sculpin	Yes	17	17	0.85	17-19
Sacramento sucker	Yes	11	11	0.79	11-13

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Station GRBONUS only has two years of comparable data (since the station was first sampled in 2020). However, no *O. mykiss* were captured in either year, resulting in an average density of 0.00 *O. mykiss*/m.

Guadalupe River Discussion

No *O. mykiss* were collected at any of the stations sampled on the Guadalupe River in 2021. Based on the previous Guadalupe River Project monitoring efforts (2004-2020), it is not uncommon for this species to be absent or in low abundance at individual monitoring stations on the mainstem. Since initiating sampling in 2004, no monitoring station in the Guadalupe River has consistently captured *O. mykiss*. A single *O. mykiss* was captured during the 2019 sampling effort after a four-year span without any *O. mykiss* detections within the Guadalupe River.

There have been no obvious changes in physical habitat on the Guadalupe River that would have triggered the decreased *O. mykiss* capture rates over the last few years. All stations sampled contained habitat complexity (i.e., undercut banks, large woody debris, or submerged roots) that could be used as refugia, as well as riffle habitat that should support fast-water feeding requirements. The measurable objectives for streamside vegetation in the Downtown Project are being met, and other fisheries monitoring indicators, such as suitable habitat area (for juvenile *O. mykiss*), have indicated that habitat is available and consistent with unaltered index reaches (Valley Water and Stillwater Sciences 2021).

Turbidity levels were elevated on Guadalupe River, but temperatures and dissolved oxygen levels were suitable to support *O. mykiss* at the time of sampling. Conductivity in Guadalupe River ranged from 1070 to 1180 µS/cm. The conductivity of U.S. rivers typically ranges from 50 to 1500 µS/cm, but industrial waters can be as high as 10,000 µS/cm. Studies suggest that streams supporting good mixed fisheries have a range between 150 and 500 µS/cm; conductivity outside of this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. Geology, temperature, and discharges to streams can all affect conductivity levels (EPA 2012).

Monitoring efforts in 2020 indicated that native fish populations did not rebound after the severe drought conditions from 2014 to 2016. To further limit the ability for populations to rebound, another drought from 2020 to 2021 reduced stream flow and induced dry backs in the Guadalupe River. Prior to 2014, the average annual catch of all native fish in the four consistently sampled stations on the Guadalupe River (GR001-GR004) was 4.49 fish/m. The most abundant native fish species during that time period was SCC roach. In 2015 and 2016, some stations were completely dry or yielded zero fish, and from 2015 to 2019, the average annual catch of all native fish was only 0.89 fish/m. From 2020 to 2021, some stations were again completely dry, and the average annual catch of native fish at GR001 and GR003 (GR002 and GR004 could not be sampled) was 0.64 fish/m. Although this is only data from two stations rather than four, it is still indicative of low native fish abundance compared to pre-drought years and in the midst of the current drought. While abundance of native fish has declined, the proportion of non-native species captured was low in the Guadalupe River Watershed in 2021, with eight native species comprising 97.2% of the catch, and two non-native species making up the remaining 2.8%. The non-native fish in Guadalupe River were all captured at the most downstream sampling location.

3.2 Guadalupe Creek

Sampling occurred at four stations on Guadalupe Creek on November 4, 2021, and weather conditions ranged from mostly to partly cloudy. Based on ALERT Gage 5017 - Guadalupe Creek below Guadalupe Reservoir, flows at the four sampling stations (GC003 – GC006) were 1.4 cfs. GC001 was not sampled this year because the stretch experienced a dry back. At the time of sampling, GC002 was wetted from ground water influence but isolated from the upstream reaches of Guadalupe Creek. The station had consistently been dry for several months prior to sampling and therefore did not seem useful to sample.

GC003

With the exception of 2014, this station was sampled in every year during the previous monitoring efforts from 2004 to 2020. The station is upstream of Masson Dam and is in an urban residential area. GC003 was 40 m in length with an average wetted width of 1.75 m and an average depth of 0.15 m. Three habitat types were present within the station: riffle (58%), run (30%), and pool (12%) (Figure 11). The primary substrate was cobble with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 10.

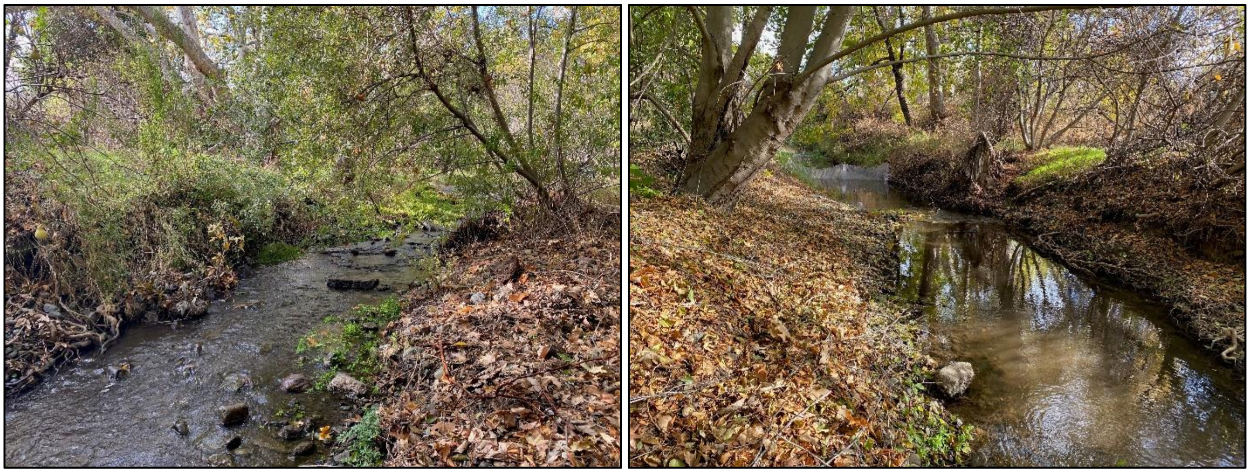

Figure 11. Photos of station GC003 looking upstream (left) and looking downstream (right).

Table 10. GC003 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
601	14.77	9.72	12.80

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
2	1	0	1	3	2	0

Three species of fish were captured and all were native: *O. mykiss*, SCC roach, and riffle sculpin (*Cottus gulosus*). The most abundant species encountered was riffle sculpin (n=39). The one *O. mykiss* captured was ≥ 65 mm fork-length and thus was PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 11. The MLIP for GC003 indicated that the number of SCC roach within the reach was slightly higher than what was captured. The MLIP did not show that the riffle sculpin population was higher than observed, and a population estimate could not be calculated for *O. mykiss* as only one individual was captured.

Table 11. Number of fish captured and population estimates at station GC003.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	20	21	1.81	20-25
O. mykiss	Yes	1	-	-	-
Riffle sculpin	Yes	39	39	0.96	39-41

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Station GC003 now has 17 years of comparable *O. mykiss* capture data between 2004 and 2021, excluding 2014 when no sampling occurred (Figure 12). *O. mykiss* were captured at this station in all but four years. This reach did not experience dry-back as a result of the drought in 2015, but flow conditions were low and no *O. mykiss* were observed in 2015 or 2016. *O. mykiss* did return in 2017, though in low numbers. The average *O. mykiss* density at this site between 2004 and 2020 was 0.14 *O. mykiss*/m. In 2021, the observed density was 0.03 *O. mykiss*/m. A more detailed analysis of *O. mykiss* capture data is provided in the “Guadalupe Creek Discussion” section later in this document.

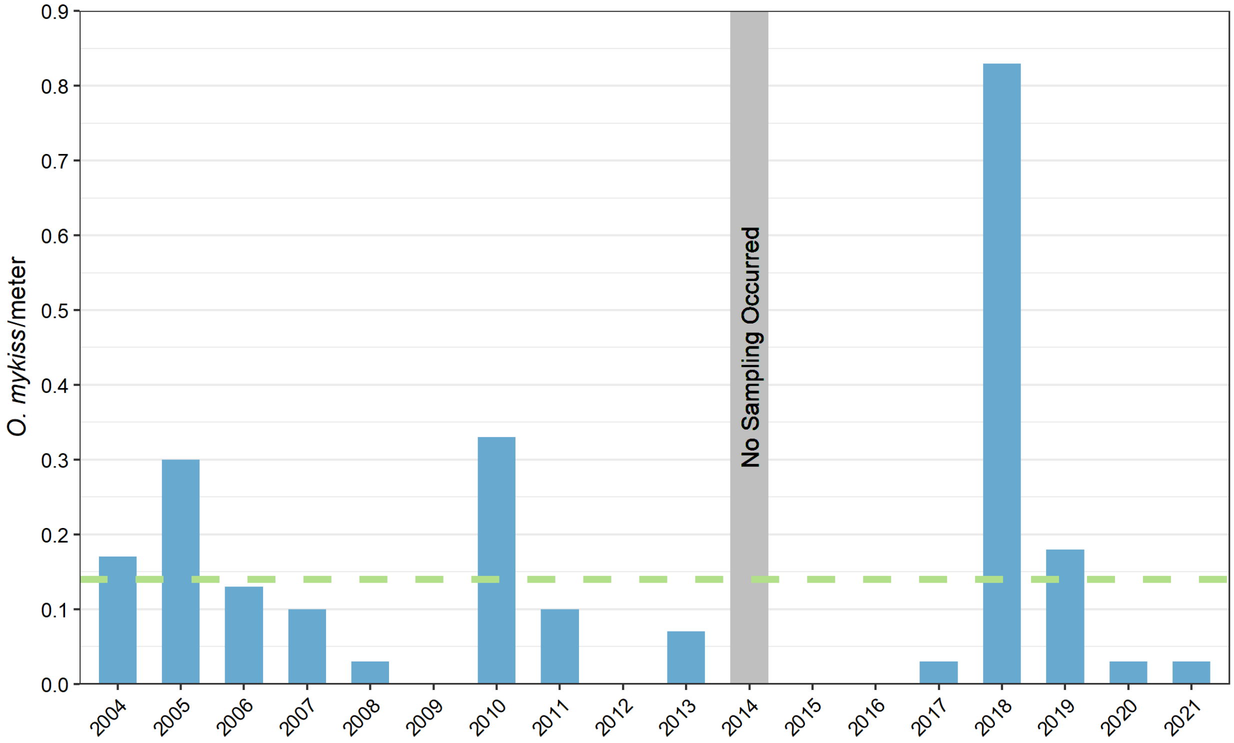

Figure 12. Station GC003 standardized *O. mykiss* capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station.

GC004

GC004 was also sampled during the previous monitoring efforts between 2004 and 2020 (not including 2014). The station is situated amongst rural residential areas. The monitoring station was 40 m in length with an average wetted width of 3.5 m and an average depth of 0.2 m. Two habitat types were present within the station: riffle (48%) and run (52%) (Figure 13). The primary substrate was cobble with a secondary substrate of silt. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 12. A turbidity measurement was not captured at this site due to a meter malfunction.

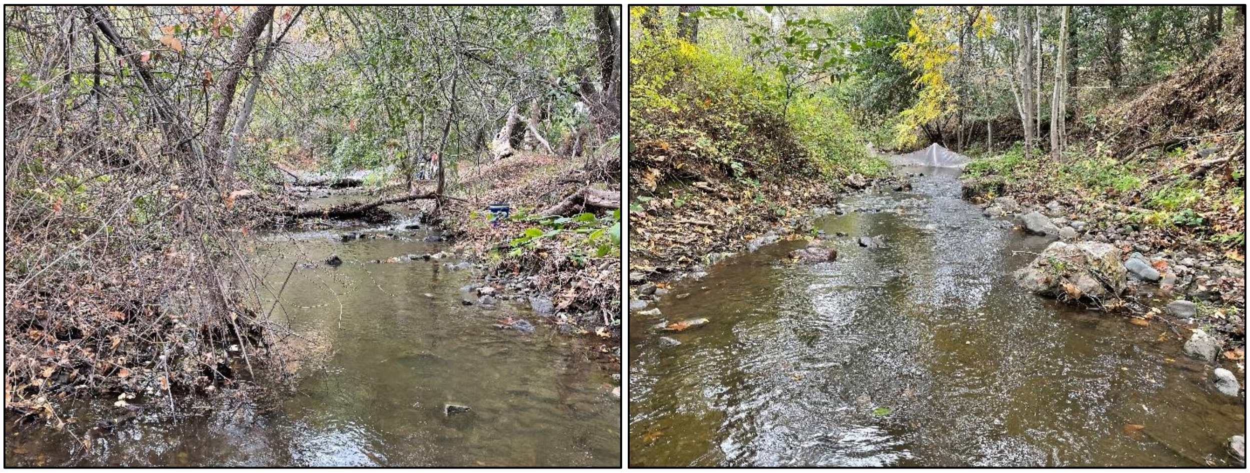

Figure 13. Photos of station GC004 looking upstream (left) and looking downstream (right).

Table 12. GC004 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
577	14.92	9.99	-

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	2	2	1	3	1	0

Three species of fish were captured and all were native: *O. mykiss*, SCC roach, and riffle sculpin. The most abundant species encountered was riffle sculpin (n=67), and the MLIP indicated that the population was higher than what was observed. Two *O. mykiss* were captured during the sampling effort, both of which were large enough to be PIT-tagged prior to being released. According to the MLIP, the number of *O. mykiss* present was slightly higher than what was captured (N=3). Fish captured and associated population estimates are summarized in Table 13.

Table 13. Number of fish captured and population estimates at station GC004.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	2	2	0.38	2-7
O. mykiss	Yes	2	3	0.00	3-3
Riffle sculpin	Yes	67	70	2.82	67-76

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Station GC004 has 17 years of comparable data (excluding 2014). Figure 14 shows the standardized capture of *O. mykiss* between 2004 and 2021. In all but three years, *O. mykiss* were captured at this station. This reach did not experience dry-back in 2015, but flow conditions were low and no *O. mykiss* were captured in 2015 or 2016. However, *O. mykiss* returned in 2017 and have been captured in each year since. The highest density of *O. mykiss* occurred in 2005 at 1.03 *O. mykiss*/m, which was the highest density recorded at any station in the watershed during the entire 17-year monitoring period. The average *O. mykiss* density at this site between 2004 and 2020 was 0.40 *O. mykiss*/m. The average for the 2021 monitoring was lower at 0.05 *O. mykiss*/m; however, the MLIP predicted that the *O. mykiss* population was slightly higher than what was captured. Furthermore, the reach still appears to consistently support rearing despite the lower than average observed density in 2021. A more detailed analysis of *O. mykiss* capture data is provided in the “Guadalupe Creek Discussion” section later in this document.

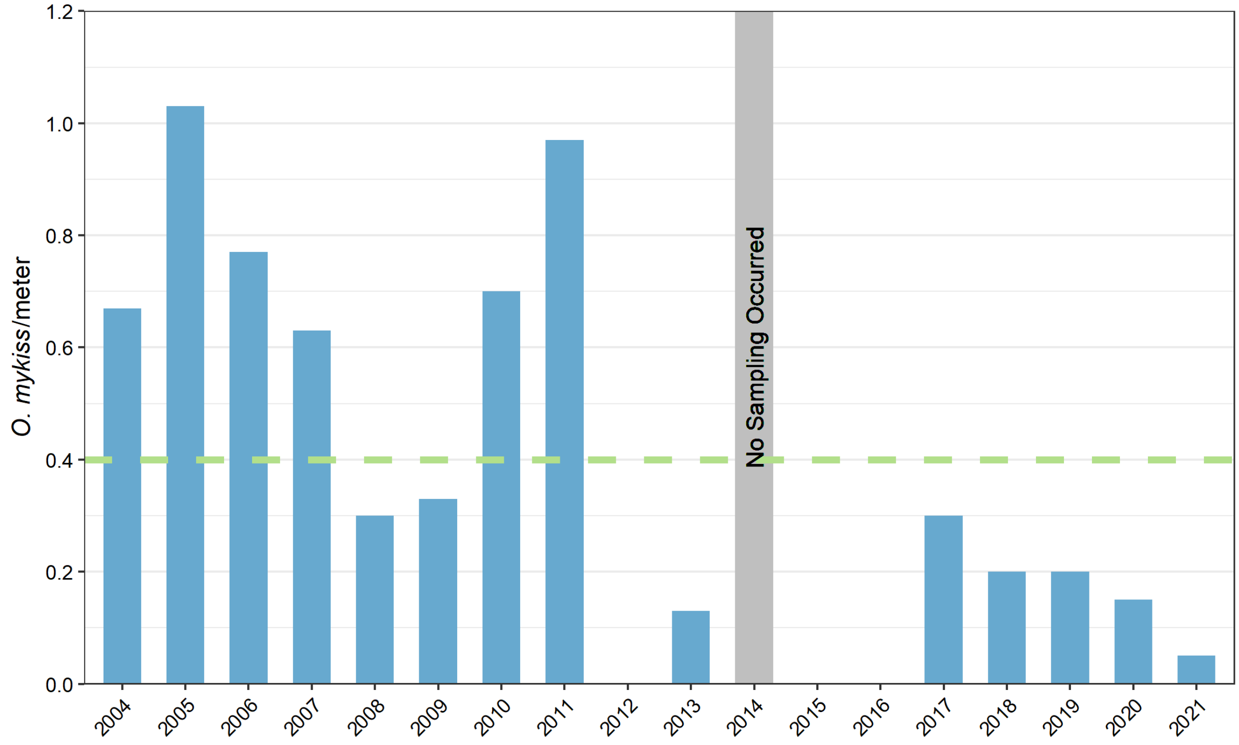

Figure 14. Station GC004 standardized *O. mykiss* capture 2004-2021. Dashed line indicates the average density from 2004-2020 at this station.

GC005

GC005 was part of the expanded monitoring effort that started in 2018; therefore, this is only the fourth year of data collection at this station. The station is surrounded by limited residential housing, with the Waste Management – Guadalupe Rubbish Disposal Facility to the east and open space to the west. The monitoring station was 40 m in length with an average wetted width of 2.5 m and an average depth of 0.15 m. Two habitat types were present within the station: riffle (68%) and run (32%) (Figure 15). The primary substrate was cobble with a secondary substrate of boulders. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 14.

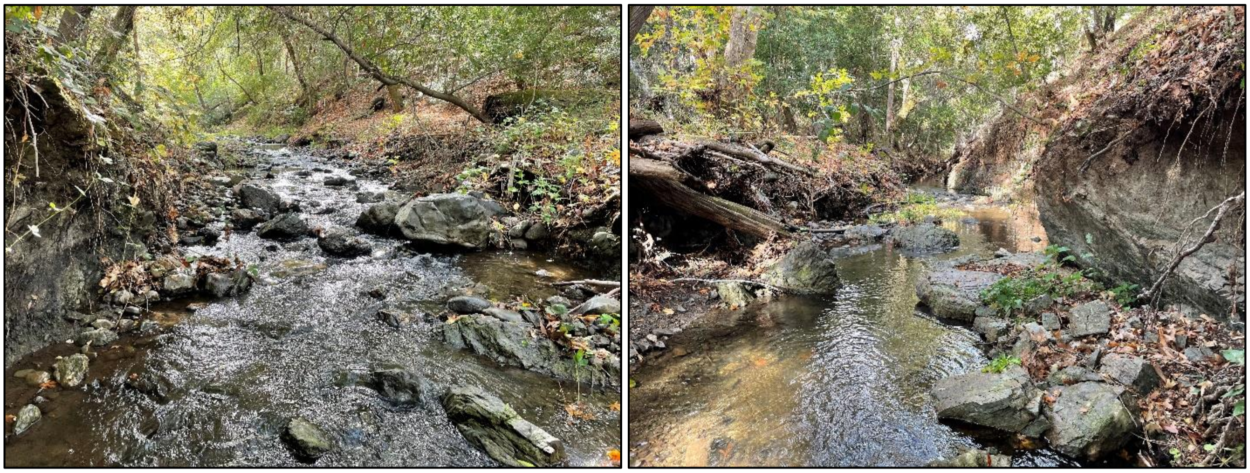

Figure 15. Photos of station GC005 looking upstream (left) and looking downstream (right).

Table 14. GC005 water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**			
569	15.04	6.02	0.00			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	3	0	1	3	2	1

Three species of fish were captured during the sampling effort and all were native: SCC roach, *O. mykiss*, and riffle sculpin. The most abundant species encountered was riffle sculpin (n=61). Two *O. mykiss* were captured during the sampling effort, both of which were ≥ 65 mm and were PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 15. The MLIP indicated that the number of riffle sculpin within the reach was likely higher than what was captured, whereas the populations of SCC roach and *O. mykiss* were likely the same as what was observed.

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Table 15. Number of fish captured and population estimates at station GC005.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	2	2	1.88	2-26
O. mykiss	Yes	2	2	0.00	2-2
Riffle sculpin	Yes	61	65	3.57	61-72

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Over the four years of sampling at this station, the lowest density of *O. mykiss* was captured in 2021 with a density of 0.05 *O. mykiss*/m. Figure 16 shows the standardized capture of *O. mykiss* between 2018 and 2021, which has steadily declined since sampling began at this station in 2018. A more detailed analysis of *O. mykiss* capture data is provided in the "Guadalupe Creek Discussion" section later in this document.

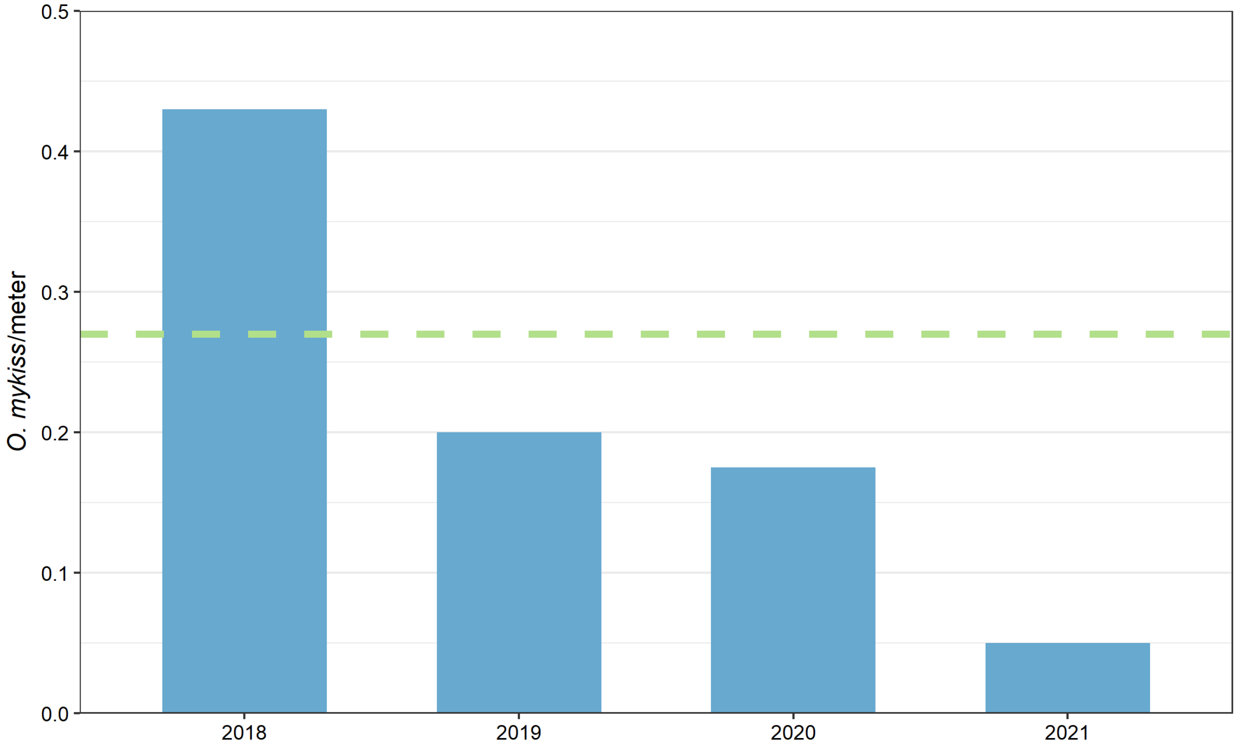

Figure 16. Station GC005 standardized *O. mykiss* capture 2018-2021. Dashed line indicates the average density from 2018-2020 at this station.

GC006

GC006 was also part of the expanded monitoring effort started in 2018. The station is surrounded by limited rural residential housing and open space to the south and was the most upstream station sampled. The monitoring station was 40 m in length with an average wetted width of 4.0 m and an average depth of 0.2 m. Three habitat types were present within the station: riffle (42%), run (33%), and pool (25%) (Figure 17). The primary substrate was cobble with a secondary substrate of silt. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 16.

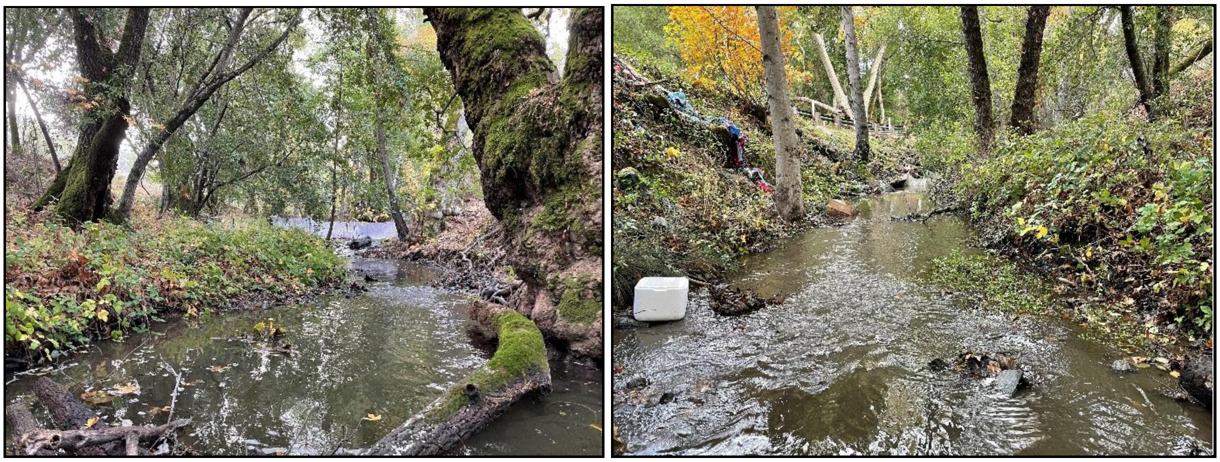

Figure 17. Photos of station GC006 looking upstream (left) and looking downstream (right).

Table 16. GC006 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
592	15.11	8.31	29.60

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
2	2	1	2	3	3	1

Four species of fish were captured during the sampling effort: SCC roach, *O. mykiss*, Sacramento sucker, and riffle sculpin. The most abundant species encountered was riffle sculpin (n=50). The one *O. mykiss* captured was large enough to be PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 17. According to the MLIP, the populations of riffle sculpin and Sacramento sucker within the sampling reach were likely higher than what was observed. The MLIP did not show that the SCC roach population was higher than observed, and a population estimate could not be calculated for *O. mykiss* as only one individual was captured.

Table 17. Number of fish captured and population estimates at station GC006.

Species	**Native**	**n**	**N**	**SE**	**95% CI**
SCC roach	Yes	3	3	1.27	3-8
O. mykiss	Yes	1	-	-	-
Riffle sculpin	Yes	50	58	6.42	50-71
Sacramento sucker	Yes	3	4	0.00	4-4

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

This was the fourth year of sampling at this station so no long-term comparisons over time can be made, but the 2020 and 2021 results for this station were lower than what was observed in 2018 and 2019. This station had an observed density (based on n) of 0.025 *O. mykiss*/m in 2021. (Figure 18). A more detailed analysis of *O. mykiss* capture data is provided in the “Guadalupe Creek Discussion” section below.

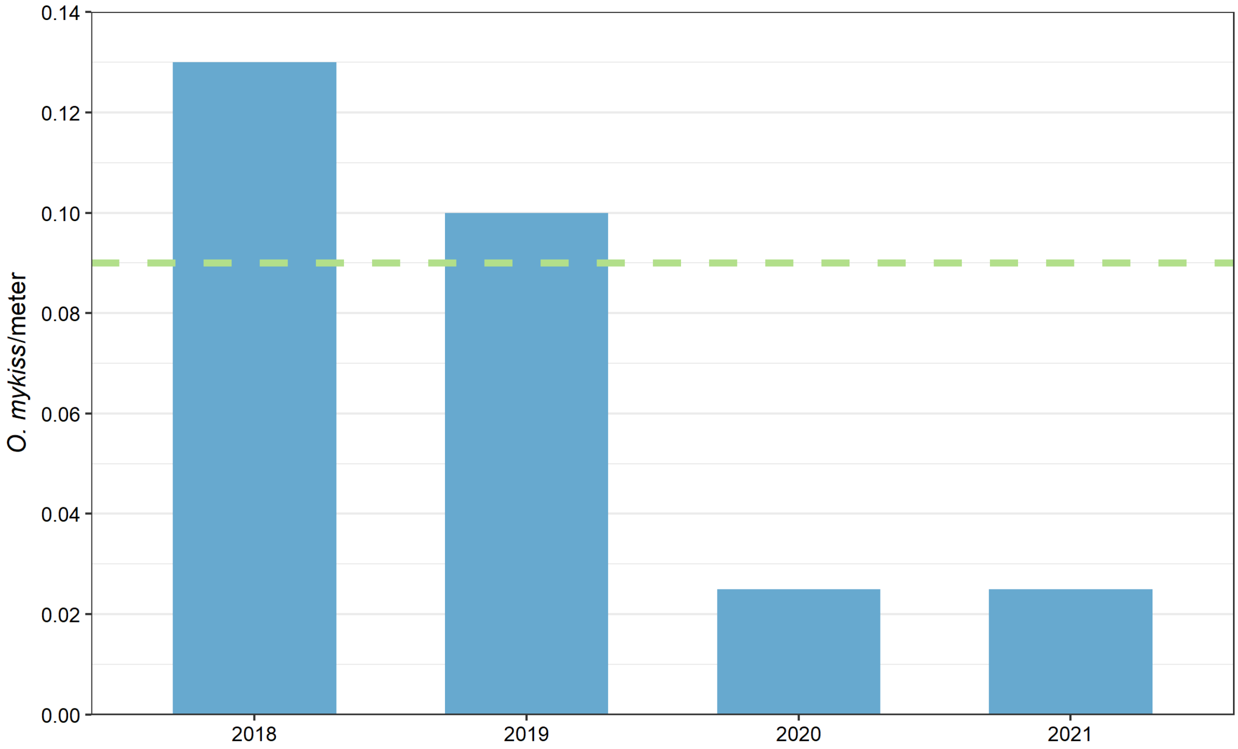

Figure 18. Station GC006 standardized *O. mykiss* capture 2018-2021. Dashed line indicates the average density from 2018-2020 at this station.

Guadalupe Creek Discussion

Guadalupe Creek supports five species of native fish (*O. mykiss*, SCC roach, prickly sculpin, riffle sculpin, Sacramento sucker) with more than one age class of *O. mykiss* present. Similar to 2020, no non-native species were captured during this year's sampling effort. Based on the results of the 2021 sampling effort, Guadalupe Creek continues to support rearing of juvenile *O. mykiss,* though in lower numbers compared to previous years. A total of six *O. mykiss* were collected spread across the four monitoring stations in 2021. The MLIP predicted the number of *O. mykiss* present to be higher than what was captured in one of the sampling reaches (GC004), but the number captured in the remaining three reaches was too small to calculate a population estimate.

Fork-lengths ranged from 78 mm to 171 mm (Figure 19). Growth rates of juvenile *O. mykiss* in California are highly variable and are dependent on temperature, food availability, seasonal flow, and population densities/competition (Moyle 2002). According to Moyle (2002), in small streams with low summer flows, such as Guadalupe Creek, young-of-the-year steelhead measure 50–90 mm, and fish at the end of their second year measure 100–160 mm. Smith and Leicester (2016) aged 32 fish from Guadalupe Creek and found that young-of-the-year *O. mykiss* ranged from 85–114 mm, and fish in their second year ranged from 110–195 mm. This is a faster growth rate than predicted by Moyle (2002), but this is expected in warmer, more productive systems. Based on Moyle (2002) and Smith and Leicester (2016) growth rates, *O. mykiss* captured in Guadalupe Creek in 2021 were evenly split between young-of-the-year and second-year fish. The presence of young-of-the-year fish indicates that Guadalupe Creek had successful reproduction and summer rearing in 2021.

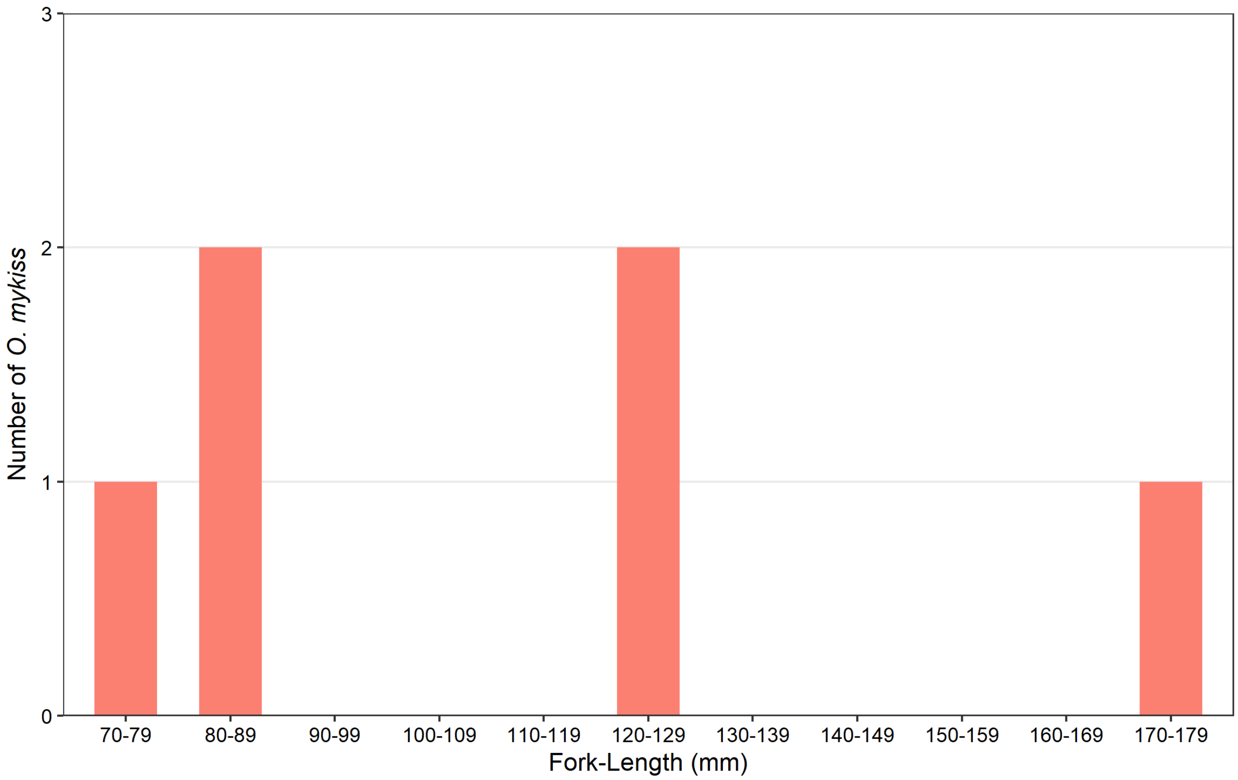

Figure 19. Guadalupe Creek 2021 *O. mykiss* fork-lengths. Measurements are binned in 10 mm increments.

The average *O. mykiss* density for all monitoring stations in 2021 was 0.04 *O. mykiss*/m (based on the number of fish caught (n)). This is half the average density from 2020

(0.08 *O. mykiss*/m) and only a quarter of the average density observed from 2004 to 2020 at the four repeatedly sampled stations (0.16 *O. mykiss*/m). However, *O. mykiss* were observed at every station sampled in 2021, indicating that juvenile rearing continues to occur throughout Guadalupe Creek. Similar to 2019 and 2020, the highest densities in 2021 were observed between the middle and upstream end of the system (stations GC004 and GC005). At all four sites sampled in 2021, *O. mykiss* capture rates have steadily declined from 2018 to 2021. Considering the two stations which have been sampled consistently since 2004, the more upstream site (GC004) has historically been more productive than GC003. 2018 was the most productive year for *O. mykiss* at GC003, followed by 2010. The most productive year at GC004 was 2005, followed by 2011.

All sites sampled had some form of physical habitat complexity suitable to support *O. mykiss*. Conductivity and turbidity were lower overall compared to Guadalupe River (ranging from 569 to 601 µS/cm, and 0 to 29.6 NTU, respectively), and temperature and dissolved oxygen levels were favorable for *O. mykiss*. Suitable conditions are normally present in Guadalupe Creek, but nonetheless, *O. mykiss* production has declined steadily at all sites sampled in recent years. Decreased production is in part due to the effects of the five-year drought from 2012 to 2016, but the 2020-2021 drought is responsible for the decline observed during the 2021 monitoring effort.

When Guadalupe Creek data from 2004 to 2021 is considered, the results indicate that *O. mykiss* production is variable, and the species is resilient. Guadalupe Creek is clearly important for production of *O. mykiss* in the larger Guadalupe River Watershed in addition to supporting an abundance of other native fish. Even with the extreme drought conditions present during sampling in 2021, *O. mykiss* were still able to persist in the system, albeit in reduced numbers.

3.3 Los Gatos Creek

Sampling occurred at three stations on Los Gatos Creek on November 10, 2021. The sky was overcast at the start of sampling and was sunny by the time sampling was completed. Flows on Los Gatos Creek were approximately 5.0 cfs based on ALERT gage 5059 – Los Gatos Creek at Lark Avenue.

LG003

LG003 was the most downstream station sampled on Los Gatos Creek and is bordered by residential development. The monitoring station was 40 m in length with an average wetted width of 3.0 m and average depth of 0.25 m. Two habitat types were present within the station: riffle (75%) and run (25%) (Figure 20). The primary substrate was cobble with a secondary substrate of boulders. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 18.

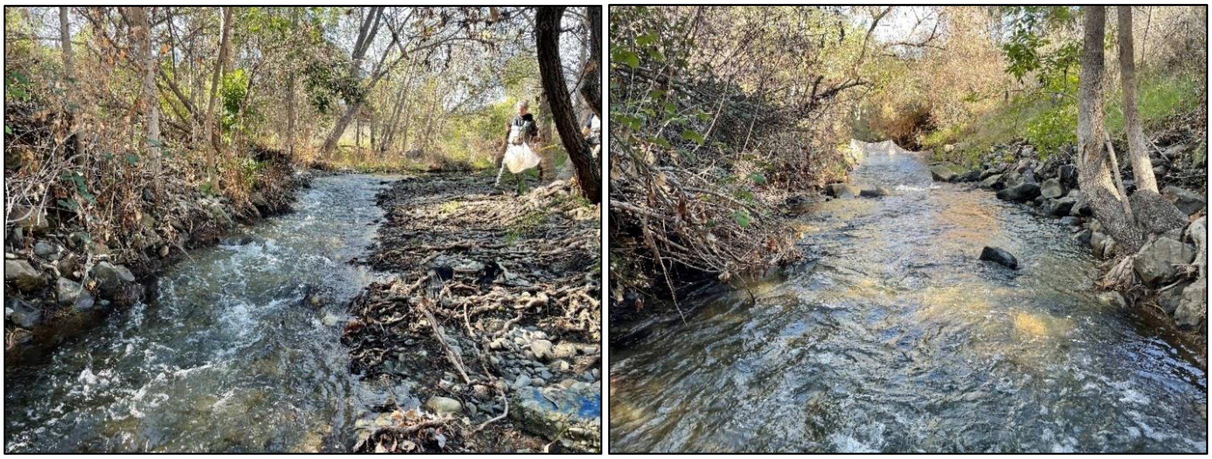

Figure 20. Photos of station LG003 looking upstream (left) and looking downstream (right).

Table 18. LG003 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
538	16.39	10.31	15.70

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	2	0	0	2	2	1

No fish of any species were captured during the first two passes; therefore, a third pass was not conducted at this station.

LGBONUS

LGBONUS was a new sampling station in 2021 located downstream of Hamilton Avenue. This site was added due to the inability to sample LG001 and LG002 and was determined to be the most easily accessible site with suitable habitat. The monitoring station was 43 m in length with an average wetted width of 6.0 m and an average depth of 0.9 m. Three habitat types were present within the station: riffle (47%) and run (53%), with a pool on one side of the channel towards the downstream end (Figure 21). The primary substrate was cobble with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 19.

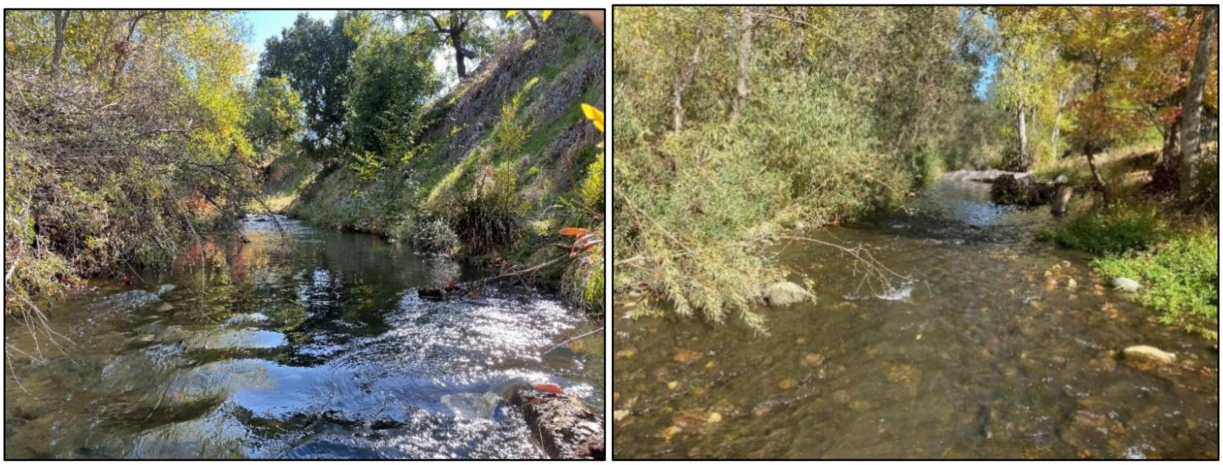

Figure 21. Photos of station LGBONUS looking upstream (left) and looking downstream (right).

Table 19. LGBONUS water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**			
539	16.97	10.01	18.6			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	1	1	0	3	1	0

Three species of fish were captured during the sampling effort: SCC roach, Sacramento sucker, and largemouth bass (*Micropterus salmoides*). Fish captured and associated population estimates are summarized in Table 20. SCC roach was the most abundant species encountered (n=5). The MLIP estimate was slightly higher for largemouth bass than what was captured but was the same for SCC roach. An estimate for Sacramento sucker could not be calculated as only one individual was captured. No *O. mykiss* were captured at this monitoring station.

Table 20. Number of fish captured and population estimates at station LGBONUS.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	5	5	0.44	5-6
Largemouth bass	No	2	3	0.00	3-3
Sacramento sucker	Yes	1	-	-	-

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

LG004

LG004 was the most upstream monitoring station on Los Gatos Creek and is situated amongst commercial development. This site was also the location of the Valley Water Stream Maintenance Program’s Los Gatos Creek Instream Habitat Complexity Project. The project was completed in fall 2019 and consisted of large woody debris installation and gravel augmentation. LG004 was 48 m in length with an average wetted width of 9.0 m and an average depth of 0.5 m. Three habitat types were present within the station: riffle (25%), run (75%), with a pool on one side of the channel in the middle section of the reach (Figure 22). The primary substrate was cobble with a secondary substrate of gravel. Most of the cobble and large woody debris present were part of the restoration project. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 21.

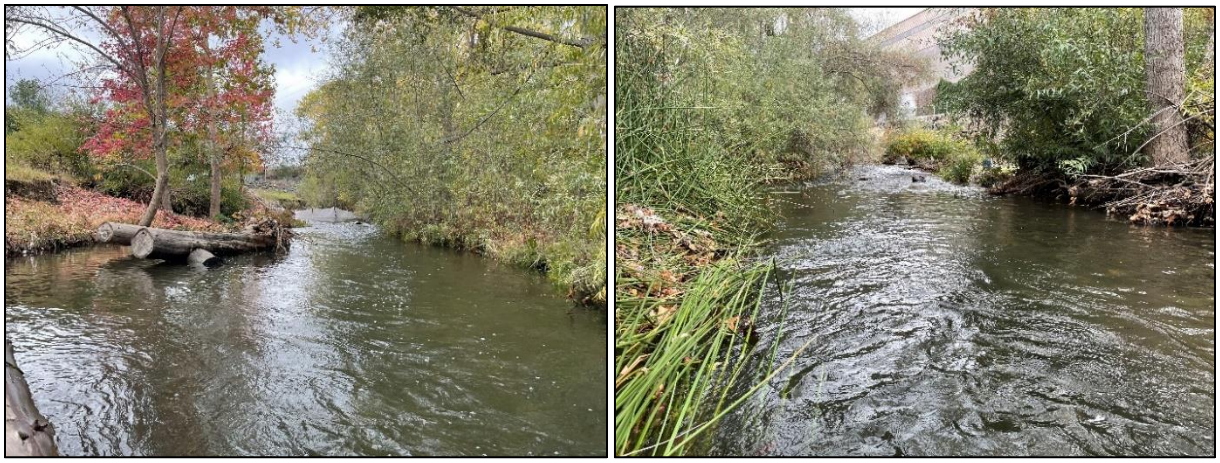

Figure 22. Photos of station LG004 looking upstream (left) and looking downstream (right).

Table 21. LG004 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
534	16.38	9.68	16.6

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
2	1	2	1	2	1	0

Five species of fish were captured during the sampling effort: SCC roach, Sacramento sucker, largemouth bass, green sunfish, and mosquitofish. Fish captured and associated population estimates are summarized in Table 22. The MLIP estimate indicated that the populations of SCC roach, Sacramento sucker, and largemouth bass were likely the same as observed, and a population estimate could not be calculated for green sunfish and mosquitofish as only one individual of each species was captured. No *O. mykiss* were captured at this monitoring station.

Table 22. Number of fish captured and population estimates at station LG004.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	2	2	0.38	2-7
Green sunfish	No	1	-	-	-
Largemouth bass	No	2	2	0.00	2-2
Mosquitofish	No	1	-	-	-
Sacramento sucker	Yes	2	2	1.04	2-15

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Los Gatos Creek Discussion

Juvenile rearing sampling on Los Gatos Creek began in 2018. No *O. mykiss* were collected in the Los Gatos Creek sub-watershed in any sampling year (2018-2021), despite the fact that all stations contained habitat complexity elements that could be used as refugia (e.g., undercut banks, large woody debris, submerged roots, etc.) and had riffle habitat that could support fast-water feeding requirements. Conductivity, turbidity, temperature, and dissolved oxygen were all within levels suitable to support *O. mykiss*. Conductivity was low compared to other creeks sampled in 2021, ranging from 534 to 539 µS/cm. Turbidity did not exceed 18.6 NTU at any of the stations sampled on Los Gatos Creek.

Currently, Los Gatos Creek has a higher richness of non-native species compared to other systems in the Guadalupe River Watershed, although suitable habitat to support native fishes appears to be present in the system. In 2021, 62.5% of fish captured were native consisting of two different species, while 37.5% were non-native consisting of three different species. Largemouth bass are known to predate *O. mykiss*; however, the predator-prey relationships have not been well-studied in the Guadalupe River Watershed. Largemouth bass, as well as green sunfish, would most certainly increase competition for prey resources and could result in changes to *O. mykiss* diet composition. Green sunfish are omnivorous and known to be opportunistic piscivores. They have been documented predating juvenile Chinook salmon in catch boxes; however, it is unclear if this may occur within the river system itself (Root et al. 2016).

O. mykiss have been known to occur in the system, at least periodically, as they have been observed by others. For example, Hobbs et al. (2014) sampled Los Gatos Creek in January and February 2014 and captured a total of nine *O. mykiss* at two stations, but none were captured in October 2014 at a monitoring station near Bascom Avenue (Hobbs 2015). There have been no other anecdotal reports of *O. mykiss* since 2014. It is likely that *O. mykiss* production is not high in this system and/or that Los Gatos Creek has been experiencing effects from both the 2014-2016 drought and the 2020-2021 drought.

Los Gatos Creek had a relatively low abundance of fish this year, and one of the three stations contained no fish of any species. A better understanding of occurrence and trends of fish populations are expected to develop over time as additional data is collected in future years.

3.4 Alamitos Creek

Sampling occurred at five stations on Alamitos Creek on October 28 and 29, 2021. The weather was sunny and clear with no precipitation on both sampling days. Based on ALERT gage 5016 – Alamitos Creek below Almaden Reservoir, flows at the two most upstream stations (AC003 and AC004) were approximately 3.3 to 5.1 cfs. Flows at the three most downstream stations (AC001, AC002, and ACBONUS), which are located downstream of the confluence with Calero Creek, were roughly 11.5 to 13.8 cfs based on ALERT gage 5070 – Alamitos Creek at Graystone. Stations AC001 and AC003 experienced dry back in the summer, and an October storm event restored flow to the reaches shortly before sampling occurred.

AC001

AC001 was the most downstream station sampled on Alamitos Creek in 2021. The station is situated in an urban residential area with a walking trail along the east bank. The monitoring station was 40 m in length with an average wetted width of 3.0 m and an average depth of 0.2 m. Two habitat types were present within the station: riffle (70%) and run (30%) (Figure 23). The primary substrate was cobble with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 23.

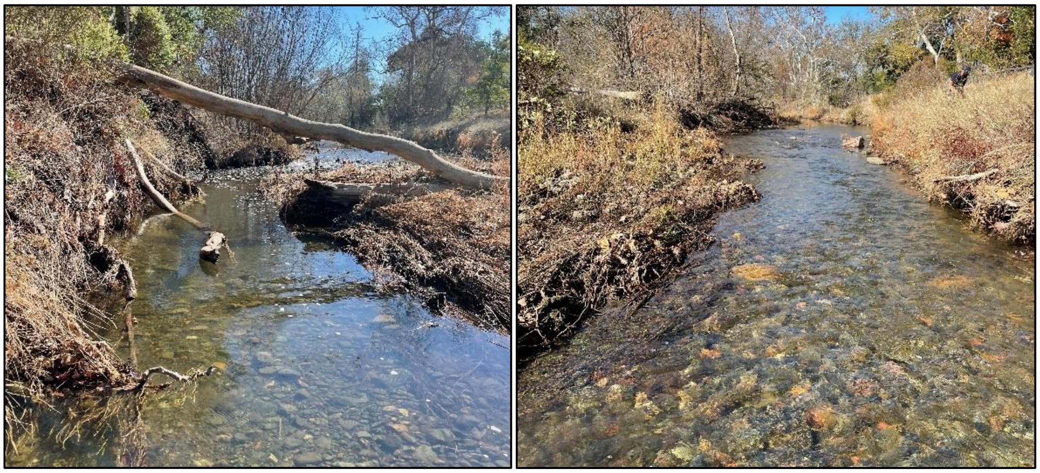

Figure 23. Photos of station AC001 looking upstream (left) and looking downstream (right).

Table 23. Station AC001 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
690	17.34	6.33	5.50

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
0	2	1	3	1	2	0

Two species of fish were captured during the sampling effort: SCC roach and largemouth bass. SCC roach was the more abundant species (n=10). Fish captured and associated population estimates for AC001 are summarized in Table 24. According to the MLIP, the estimated population of SCC roach was higher than what was observed, whereas the population of largemouth bass was likely the same as the observed number. No *O. mykiss* were captured at this station.

Table 24. Number of fish captured and population estimates at station AC001.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	10	15	0.00	15-15
Largemouth bass	No	6	6	1.38	6-10

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

AC002

AC002 is situated in an urban residential area with a walking trail along the south bank. The monitoring station was 40.5 m in length with an average wetted width of 4.0 m and an average depth of 0.8 m. Three habitat types were present within the station: riffle (44%), run (49%), and pool (7%) (Figure 24). The primary substrate was cobble with a secondary substrate of silt. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 25.

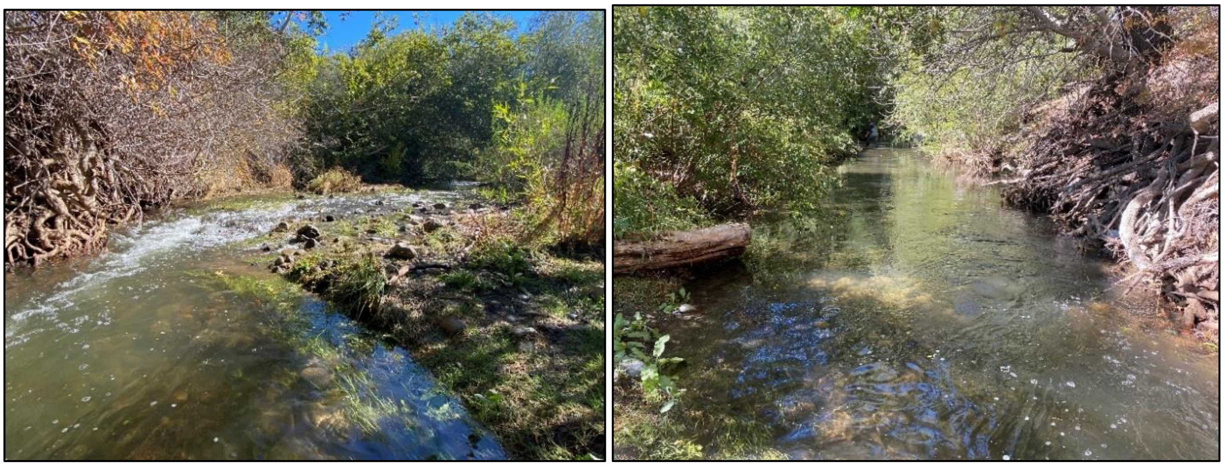

Figure 24. Photos of station AC002 looking upstream (left) and looking downstream (right).

Table 25. AC002 water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**			
670	17.10	6.91	11.60			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
2	2	1	0	3	1	0

Prickly sculpin was the only species of fish captured during the sampling effort at AC002. The number captured and associated population estimate are provided in Table 26. The MLIP estimated the population of prickly sculpin within the reach to be the same as the number observed.

Table 26. Number of fish captured and population estimates at station AC002.

Species	**Native**	**n**	**N**	**SE**	**95% CI**
Prickly sculpin	Yes	3	3	0.27	3-4

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

ACBONUS

The location of this station is subject to change each year, with the purpose being to increase *O. mykiss* capture and thereby the number of PIT tags in the system. In 2021, this station was located downstream of the Calero Creek confluence between stations AC002 and AC003 and situated in an urban residential area with a recreational trail along the west bank. The monitoring station was 40 m in length with an average wetted width of 9.0 m and an average depth of 0.5 m. Three habitat types were present within the station: riffle (75%), run (13%), and pool (12%) (Figure 25). The primary substrate was cobble with a secondary substrate of silt. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 27.

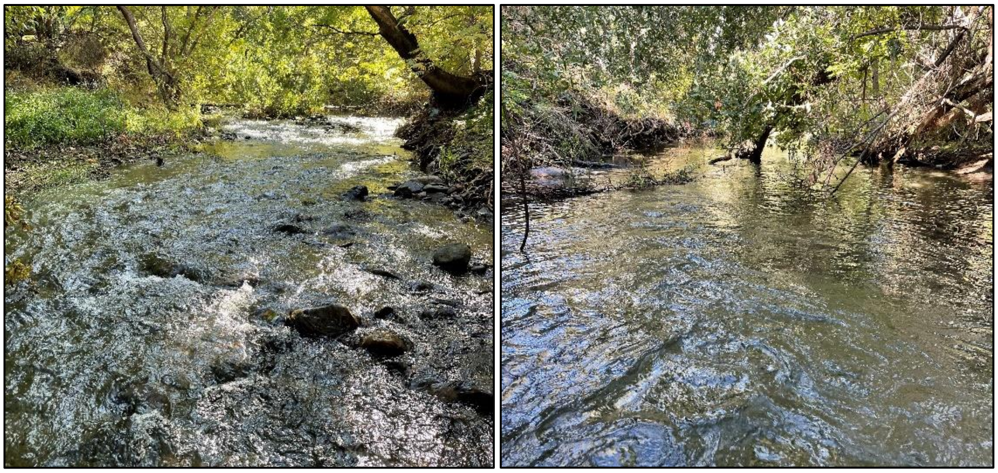

Figure 25. Photos of station ACBONUS looking upstream (left) and looking downstream (right).

Table 27. ACBONUS water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
655	16.49	6.59	23.50

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	0	2	1	3	2	0

Two species of fish were captured during the sampling effort, and both were native: *O. mykiss* and SCC roach. Two *O. mykiss* were captured, both of which were PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 28. The MLIP estimated the population of *O. mykiss* to be equal to the number observed, but a population estimate could not be calculated for SCC roach as only one individual was captured. A more detailed analysis of *O. mykiss* capture data is provided in the “Alamitos Creek Discussion” section later in this document.

Table 28. Number of fish captured and population estimates at station ACBONUS.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	1	-	-	-
O. mykiss	Yes	2	2	0.38	2-7

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

AC003

AC003 is located upstream of the Calero Creek confluence and is situated in an urban residential area. The west bank of the reach is lined with large boulders that were placed by an earlier bank protection project. The monitoring station was 40 m in length with an average wetted width of 3.0 m and an average depth of 0.1 m. Most of the station was a split channel divided by a vegetated island. Four habitat types were present within the station: riffle, step-run, run, and pool (Figure 26). The west channel consisted of 45% riffle and a 43% step-run complex created by the boulders. The east channel was 20% riffle and 68% run, and the channels joined to a pool that comprised 12% of the sampling reach. The primary substrate was cobble with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 29.

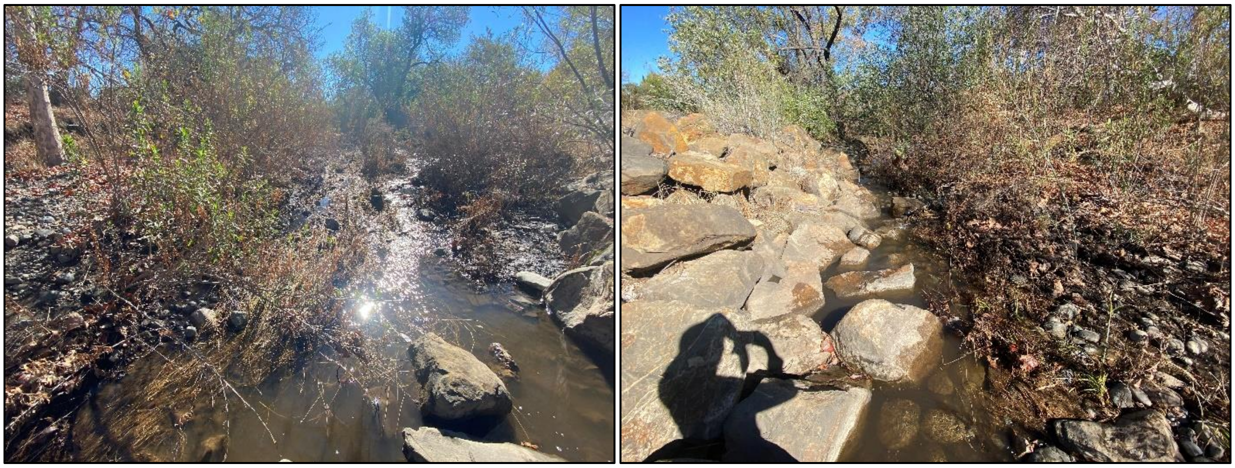

Figure 26. Photos of station AC003 looking upstream (left) and looking downstream (right).

Table 29. AC003 water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**			
535	16.70	8.80	2.50			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
2	2	0	0	1	0	0

Two species of fish were captured during the sampling effort, and both were native: SCC roach and Sacramento sucker. SCC roach was the more abundant species (n=4). Fish captured and associated population estimates are summarized in Table 30. According to the MLIP, the estimated population of both species was equal to what was observed. No *O. mykiss* were captured at this station.

Table 30. Number of fish captured and population estimates at station AC003.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	4	4	0.97	4-7
Sacramento sucker	Yes	2	2	1.88	2-26

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

AC004

AC004 was the most upstream station sampled on Alamitos Creek. A portion of the station is underneath the Almaden Way bridge, which connects Almaden and Bertram Roads, and the bridge footing extends into the channel. The monitoring station was 40 m in length with an average wetted width of 5.0 m and an average depth of 0.5 m. Four habitat types were present within the station: riffle (28%), run (48%), pool (18%), and cascade (6%) (Figure 27). The primary substrate was cobble with a secondary substrate of silt. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 31.

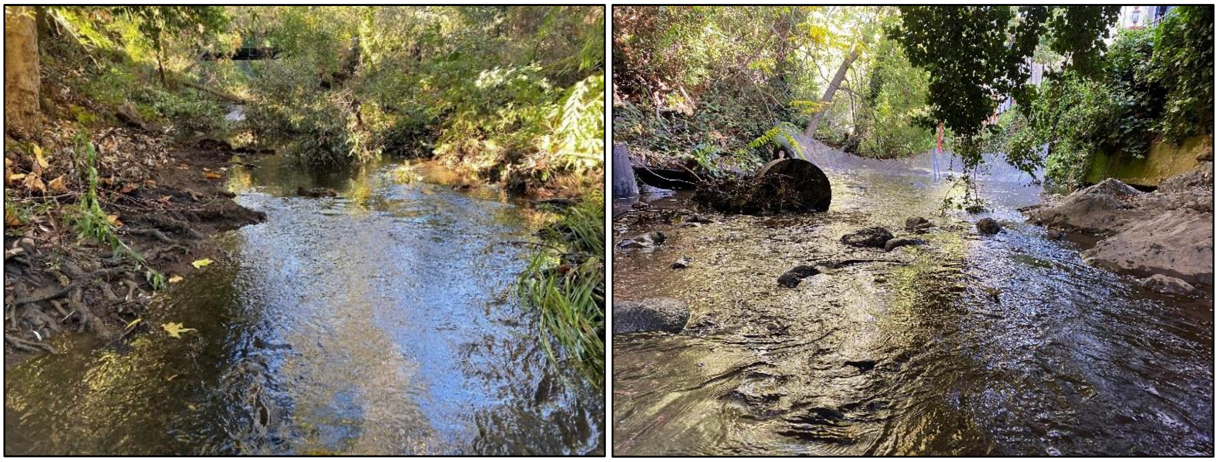

Figure 27. Photos of station AC004 looking upstream (left) and looking downstream (right).

Table 31. AC004 water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
412	15.33	10.23	4.00

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	2	3	1	3	1	1

Three species of fish were captured during the sampling effort, and all were native: *O. mykiss,* SCC roach, and Sacramento sucker. SCC roach was the most abundant species present (n=16). One *O. mykiss* was captured and was large enough to be PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 32. According to the MLIP, the estimated population of SCC roach was higher than what was observed, but population estimates could not be calculated for the other two species as only one individual of each was captured. A more detailed analysis of *O. mykiss* capture data is provided in the “Alamitos Creek Discussion” section below.

Table 32. Number of fish captured and population estimates at station AC004.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	16	19	4.75	16-29
Sacramento sucker	Yes	1	1	0.73	1-1
O. mykiss	Yes	1	1	0.00	1-1

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Alamitos Creek Discussion

Three *O. mykiss* were collected across all five Alamitos Creek monitoring stations in 2021, which amounted to an average density of 0.02 *O. mykiss*/m. The average density in 2020 was 0.12 *O. mykiss*/m and was 0.25 *O. mykiss*/m in 2019 and 0.20 *O. mykiss*/m in 2018. While individual stations saw fluctuations in *O. mykiss* numbers from 2018 to 2021, there were much fewer individuals present on average in 2021 compared to previous years, with some stations having no detections of the species (Figure 28). Two of the stations with no detections (AC001 and AC003) experienced dry back during the summer and were only rewetted shortly before sampling took place. Overall, the fewer numbers of *O. mykiss* observed in Alamitos Creek in 2021 can be attributed to the current drought that began in 2020, which has significantly reduced stream flows and increased the frequency and duration of dry backs.

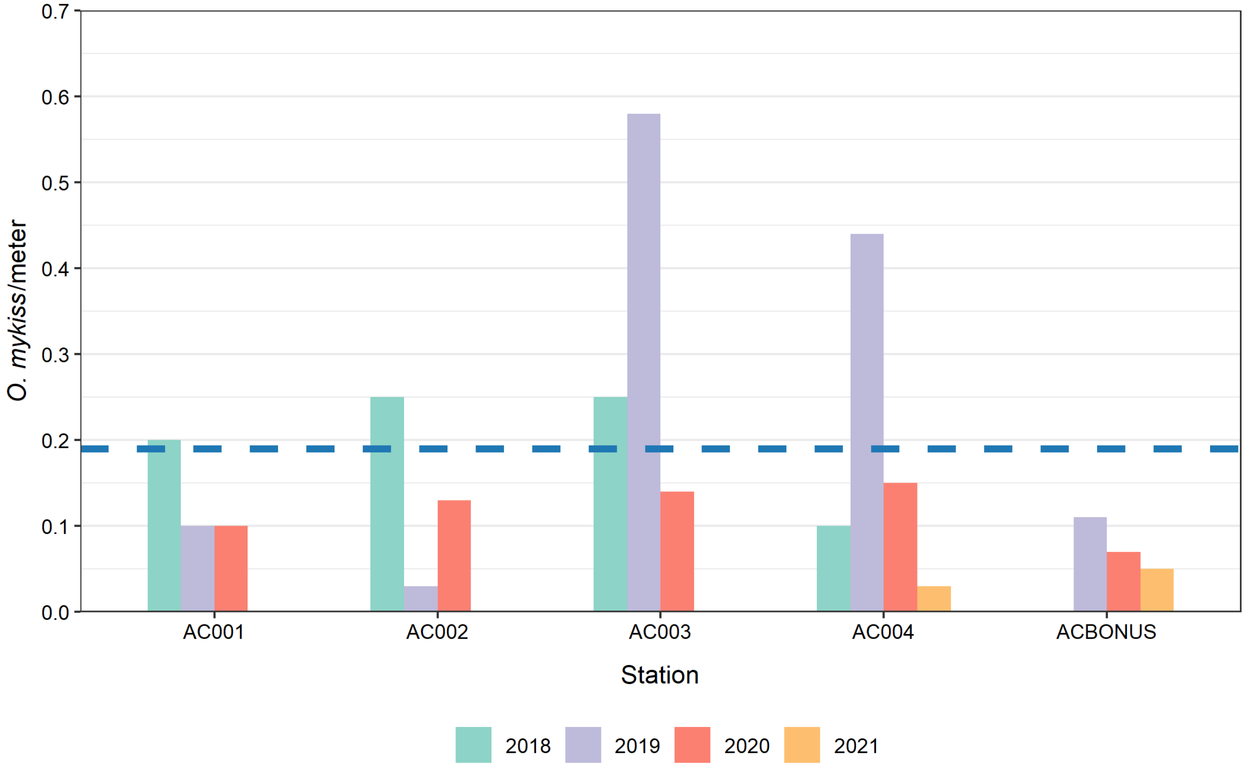

Figure 28. 2018-2021 *O. mykiss* capture densities across all Alamitos Creek monitoring stations. Dashed line indicates the average density from 2018-2020. Note that ACBONUS densities cannot be directly compared between years since the station location changes each year.

O. mykiss fork-lengths ranged from 75 mm to 84 mm; two fish were 75 mm, and one fish was 84 mm. Based on Moyle (2002) and Smith and Leicester (2016) growth rates, all three *O. mykiss* were young-of-the-year fish, indicating that reproduction and summer rearing occurred in Alamitos Creek in 2021. However, it appears that production and/or survival of juvenile *O. mykiss* in 2021 was low.

O. mykiss in this system continue to show signs of the *Neascus* spp. infection commonly known as black spot disease[2]. All three fish had visible symptoms, with one having a low infection (cysts covered <10% of the body) and two having a moderate infection (cysts covered 10-25% of the body). Of all the systems sampled in 2021, black spot disease was most prevalent in Alamitos Creek, which was also the case in 2019 and 2020 (black spot disease severity was documented for the purposes of this report beginning in 2019). The reason for the higher prevalence of black spot disease observed in Alamitos Creek is unclear, as well as its effects, if any, on *O. mykiss* health and condition.

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[2] Black spot disease is the common name for a parasitic infection of the developing stage, or metacercaria, of *Digenea* flatworms that produce a melanin-induced fibrous cyst (Schaaf et al. 2017).

All sites sampled had some form of habitat complexity suitable to support *O. mykiss* and water quality characteristics were all within acceptable ranges. Native species made up 87% of the catch in 2021, with the majority being SCC roach (67.4%). One non-native species was observed, largemouth bass, which made up 13% of the total catch (n=6).

3.5 Calero Creek

Sampling occurred at three stations on Calero Creek on November 18, 2021. Weather conditions ranged from mostly to partly cloudy. Flows on Calero Creek based on ALERT gage 5013 - Calero Creek below Calero Reservoir were approximately 0.9 cfs during the sampling period.

CC001

CC001 was the most downstream station sampled on Calero Creek. The station was situated in an urban residential area approximately 300 m upstream of the confluence with Alamitos Creek. The monitoring station was 40 m in length with an average wetted width of 2.0 m and an average depth of 0.2 m. Three habitat types were present within the station: riffle (20%), run (63%), and pool (17%) (Figure 29). The primary substrate was silt with a secondary substrate of gravel. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 33.

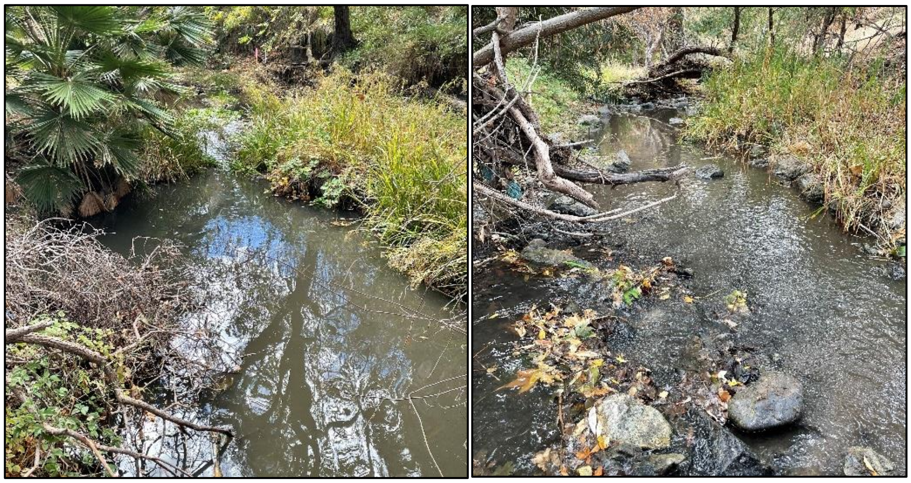

Figure 29. Photos of station CC001 looking upstream (left) and looking downstream (right).

Table 33. CC001 water quality data and ocular estimates of habitat complexity.

<table>
<tr><th colspan="7">Water Quality</th></tr>
<tr><th colspan="2">Conductivity (µS/cm)</th><th>Temperature (°C)</th><th colspan="2">Dissolved Oxygen (mg/L)</th><th colspan="2">Turbidity (NTU)</th></tr>
<tr><td colspan="2">670</td><td>14.48</td><td colspan="2">7.76</td><td colspan="2">18.50</td></tr>
<tr><th colspan="7">Habitat Complexity Scoring</th></tr>
<tr><th>Macrophytes/Emergent Vegetation</th><th>Boulders</th><th>Woody Debris</th><th>Undercut Banks</th><th>Overhanging Vegetation</th><th>Roots</th><th>Artificial Structures</th></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>3</td><td>1</td><td>0</td></tr>
</table>

Three species of fish were captured during the sampling effort: Sacramento sucker, tule perch[3] (*Hysterocarpus traskii)*, and largemouth bass. Sacramento sucker was the only native species present. Three individuals of each species were captured. Fish captured and associated population estimates are summarized in Table 34. According to the MLIP, the estimated population of largemouth bass was higher than what was observed but was the same for tule perch and Sacramento sucker. No *O. mykiss* were captured at this station.

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[3] Tule perch are native to California and were observed in the Coyote Creek Watershed as far back as 1922 (Hubbs 1925). This species was thought to be extirpated in Santa Clara County until 1999 when a single specimen was captured in Coyote Creek (Valley Water 2015). Tule perch do not show up in historic records for the Guadalupe River Watershed but are now established in Calero Reservoir (Valley Water 2017). It is assumed that the reservoir is the source for the population in Calero Creek. Though the species is regionally native, it was likely not present in the Guadalupe River Watershed until introductions to Calero Reservoir, which is why it is deemed nonnative in this report. Tule perch are not considered to be a predator of *O. mykiss*.

Table 34. Number of fish captured and population estimates at station CC001.

Species	Native	n	N	SE	95% CI
Largemouth bass	No	3	5	9.68	3-32
Tule perch	No	3	3	0.27	3-4
Sacramento sucker	Yes	3	3	0.00	3-3

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

CCBONUS

Because CC003 did not contain suitable habitat during 2021 sampling, CCBONUS was added in order to increase the number of sampling stations and opportunities for PIT-tagging of *O. mykiss*. This station was located between stations CC001 and CC002 and situated in an urban residential area. The monitoring station was 40 m in length with an average wetted width of 1.8 m and an average depth of 0.15 m. Two habitat types were present within the station: riffle (55%) and run (45%) (Figure 30). The primary substrate was silt with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 35.

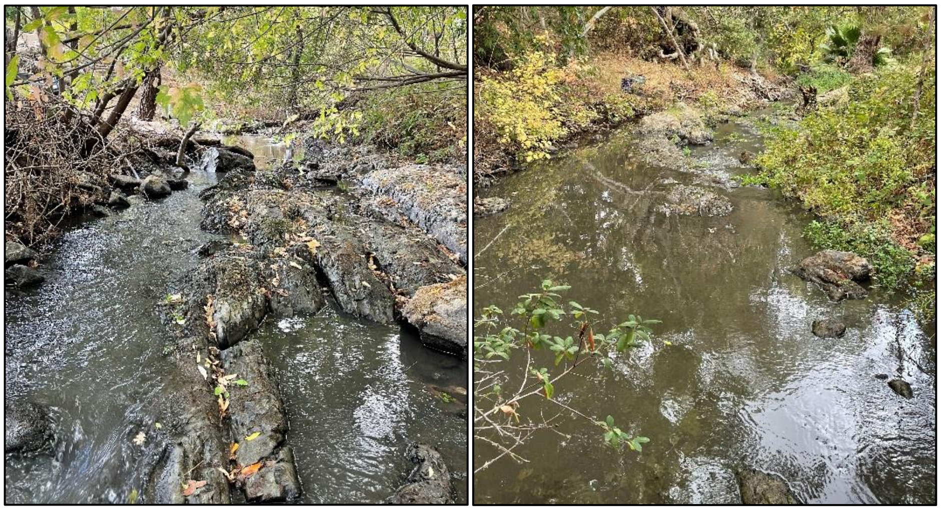

Figure 30. Photos of station CCBONUS looking upstream (left) and looking downstream (right).

Table 35. CCBONUS water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**
662	14.77	8.18	79.30

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	1	1	1	3	1	0

Three species of fish were captured during the sampling effort and all were native: *O. mykiss,* SCC roach, and Sacramento sucker. The most abundant species encountered was *O. mykiss* (n=20). All 20 *O. mykiss* captured at this station were PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 36. According to the MLIP, the estimated populations of *O. mykiss* and Sacramento sucker were slightly higher than what was captured, whereas the estimated population for SCC roach was equal to what was observed. A more detailed analysis of *O. mykiss* capture data is provided in the "Calero Creek Discussion" section later in this document.

Table 36. Number of fish captured and population estimates at station CC003.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	10	10	1.05	10-12
O. mykiss	Yes	20	21	2.09	20-25
Sacramento sucker	Yes	7	10	7.42	7-27

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

CC002

CC002 was the most upstream station sampled in 2021. CC002 was situated in an urban residential area, and a small sakrete structure at an outfall was present on the upstream end. The monitoring station was 40 m in length with an average wetted width of 1.2 m and an average depth of 0.15 m. Three habitat types were present within the station: riffle (12%), run (78%), and pool (10%) (Figure 31). The primary substrate was cobble with a secondary substrate of boulders. Results of the water quality monitoring and the ocular assessment of habitat complexity are provided in Table 37.

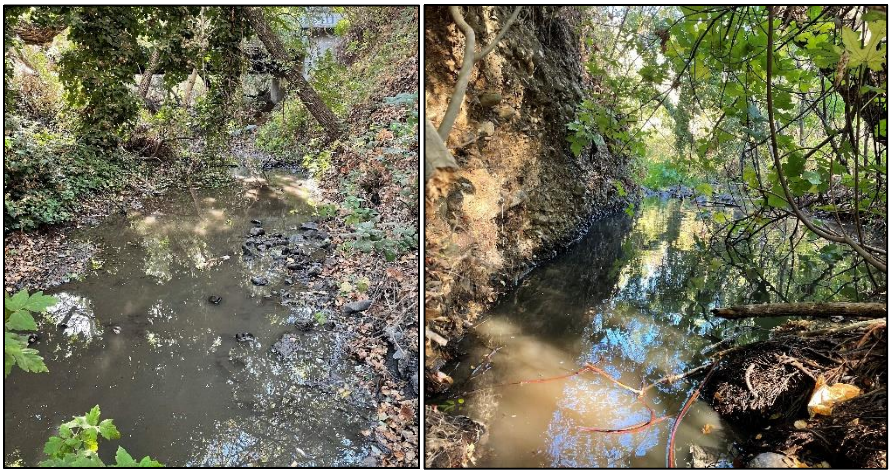

Figure 31. Photos of station CC002 looking upstream (left) and looking downstream (right).

Table 37. CC002 water quality data and ocular estimates of habitat complexity.

<table>
<tr><th colspan="7">Water Quality</th></tr>
<tr><th colspan="2">Conductivity (µS/cm)</th><th colspan="2">Temperature (°C)</th><th colspan="2">Dissolved Oxygen (mg/L)</th><th>Turbidity (NTU)</th></tr>
<tr><td colspan="2">578</td><td colspan="2">13.40</td><td colspan="2">7.90</td><td>24.60</td></tr>
<tr><th colspan="7">Habitat Complexity Scoring</th></tr>
<tr><th>Macrophytes/Emergent Vegetation</th><th>Boulders</th><th>Woody Debris</th><th>Undercut Banks</th><th>Overhanging Vegetation</th><th>Roots</th><th>Artificial Structures</th></tr>
<tr><td>1</td><td>2</td><td>1</td><td>2</td><td>3</td><td>1</td><td>1</td></tr>
</table>

Three species of fish were captured during the sampling effort and all were native: *O. mykiss*, SCC roach, and Sacramento sucker. The most abundant species encountered was Sacramento sucker (n=15). Of the eight *O. mykiss* captured at this station, four were PIT-tagged prior to being released. Fish captured and associated population estimates are summarized in Table 38. According to the MLIP, the estimated population of all three species was higher than what was observed. A more detailed analysis of *O.*

mykiss capture data is provided in the “Calero Creek Discussion” section below.

Table 38. Number of fish captured and population estimates at station CC002.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	8	12	0.00	12-12
O. mykiss	Yes	8	23	57.67	8-143
Sacramento sucker	Yes	15	21	9.32	15-40

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Calero Creek Discussion

A total of 28 *O. mykiss* were collected across all three stations sampled, but the results of the MLIP suggest that the *O. mykiss* population was higher than what was captured. The average density of *O. mykiss* in Calero Creek in 2021 was 0.23 *O. mykiss*/m, which was slightly lower than the average density observed in 2020 (0.29 *O. mykiss*/m). Nevertheless, this was still an increase from both 2019 and 2018, which had average densities of 0.07 *O. mykiss*/m and 0.14 *O. mykiss*/m, respectively (Figure 32). The average density in Calero Creek in 2021 was higher than the observed average density of repeated monitoring stations from 2004 to 2020 on Guadalupe Creek (0.17 *O. mykiss*/m) as well as the 2018-2020 average density on Alamitos Creek (0.19 *O. mykiss*/m). Guadalupe Creek and Alamitos Creek are larger sub-watersheds (38.4 and 47.8 square kilometers, respectively) with suitable *O. mykiss* habitat, so it is typically expected that they would support higher fish densities than the smaller Calero Creek sub-watershed (27.4 square kilometers). Our results show that Calero Creek plays an essential role in *O. mykiss* production, making a significant contribution to the overall population in the Guadalupe River Watershed, especially during drought years.

Black spot disease was observed in three *O. mykiss* in Calero Creek in 2021. This is an increase from both 2020 when no black spot cases were observed as well as from 2019 when two *O. mykiss* exhibited the disease. All infected *O. mykiss* in 2021 and in 2019 had a low severity infection (<10% of the body covered in cysts).

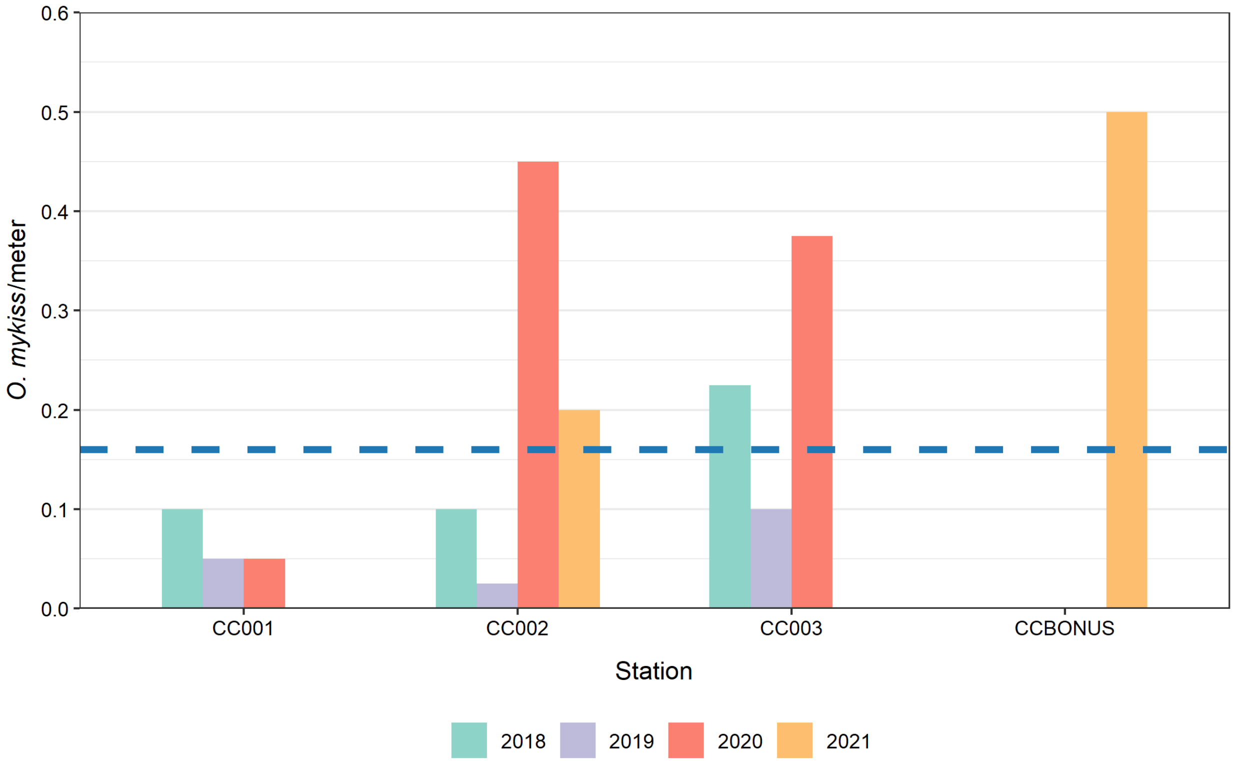

Figure 32. 2018-2021 *O. mykiss* capture densities across all Calero Creek monitoring stations. Dashed line indicates the average density from 2018-2020. Note that CC003 was not sampled in 2021 and CCBONUS was only sampled in 2021.

O. mykiss fork-lengths in 2021 ranged from 57 mm to 182 mm (Figure 33). Based on Moyle (2002) growth rates, *O. mykiss* captured in Calero Creek in 2021 were mostly young-of-the-year with a single fish potentially in its third year. However, based on Smith and Leicester (2016) growth rates from Guadalupe Creek, the largest fish may have been in its second year. Nonetheless, Calero Creek supported at least two age classes of *O. mykiss* (Figure 33). The significant number of young-of-the-year fish shows that Calero Creek had successful reproduction and summer rearing in 2021.

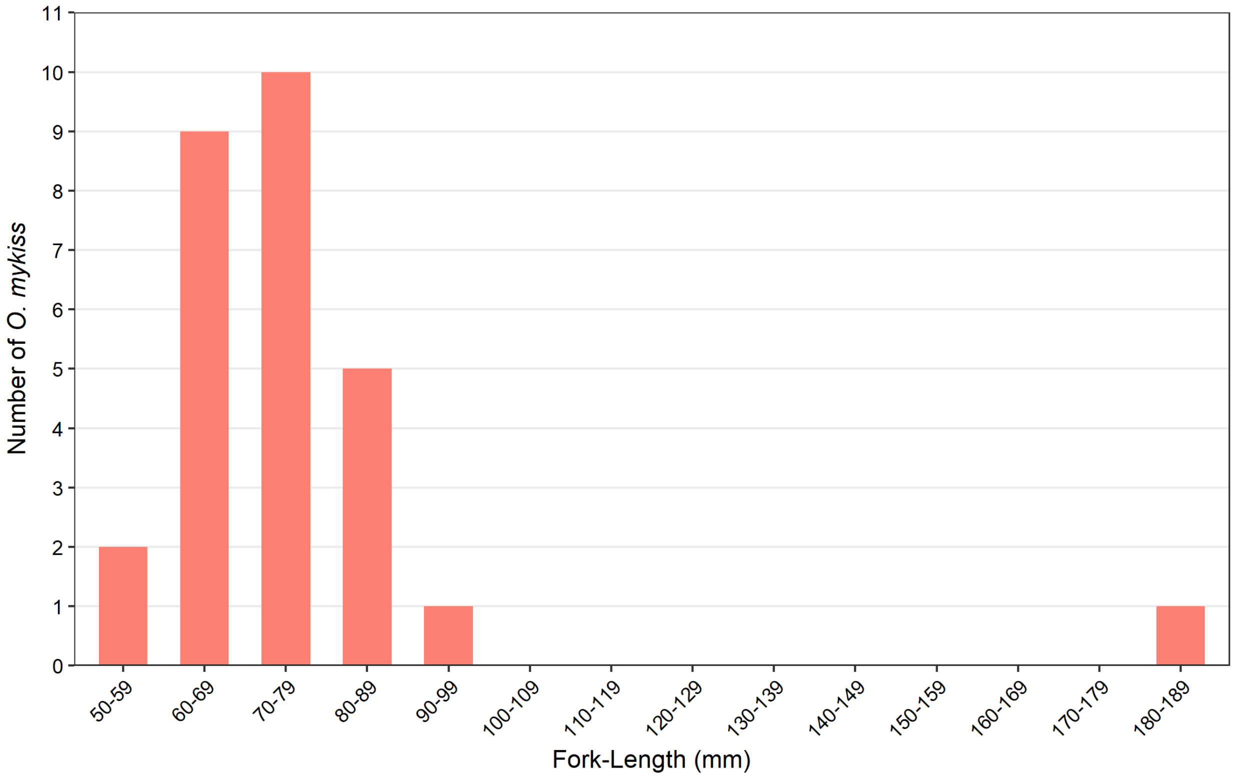

Figure 33. Calero Creek 2021 *O. mykiss* fork-lengths. Measurements are binned in 10 mm increments.

All sites sampled had some form of habitat complexity suitable to support *O. mykiss* and water quality characteristics were all within acceptable ranges. Native species made up 92% of the total catch in 2021, with the highest being *O. mykiss* (n=28). Two non-native species were observed (largemouth bass and tule perch), which made up 8% of the total catch (n=6).

4. Conclusion

Of the sites sampled in the Guadalupe River Watershed in 2021, juvenile *O. mykiss* were observed in Guadalupe Creek, Alamitos Creek, and Calero Creek. A total of 37 *O. mykiss* were captured during the monitoring effort, 33 of which were injected with PIT tags to study their movement within the watershed. The most recent results of the PIT study are available in Valley Water's Guadalupe River Watershed *Oncorhynchus mykiss* 2020 – 2021 Migration Monitoring Using Passive Integrated Transponder Tags report (Valley Water 2022), which has been updated annually since the PIT-tagging began in 2018. No *O. mykiss* were observed in Los Gatos Creek or Guadalupe River. It is unknown whether or not it is normal for no detections to occur in Los Gatos Creek in some years, since sampling this creek as part of the juvenile *O. mykiss* rearing monitoring effort only began in 2018. Based on sampling conducted in Guadalupe River since 2004, populations there are low and variable, and there have been multiple years when zero *O. mykiss* were detected. It is important to remember that electrofishing sampling only allows for specific habitats to be sampled; it is not feasible in deep pools, which may be the preferred habitat for juvenile *O. mykiss* inhabiting this system.

The average densities (*O. mykiss*/m) and median fork-length of *O. mykiss* detected in Guadalupe, Alamitos, and Calero Creeks are provided in Table 39. Calero Creek had the highest density, with Guadalupe Creek supporting *O. mykiss* with the highest fork-lengths. Figure 34 shows the size distribution of all *O. mykiss* collected in the Guadalupe River Watershed in 2021. While Guadalupe Creek is producing fish with the highest fork-lengths overall (apart from the outlier on Calero Creek), Alamitos and Calero Creeks are supporting more young-of-the-year sized fish. Based on the size range of fish collected, multiple age classes were present and *O. mykiss* production and summer rearing occurred in Alamitos, Calero, and Guadalupe Creeks in 2021. Reproduction and rearing in Guadalupe River and Los Gatos Creek is either absent or at a level that is too low to be detected by our current sampling effort.

Table 39. 2021 average density and median fork-length of *O. mykiss* captured in Alamitos, Calero, and Guadalupe Creeks.

Sub-Watershed	***O. mykiss*/m**	**Median fork-length (mm)**
Guadalupe Creek	0.04	101
Alamitos Creek	0.02	75
Calero Creek	0.23	73

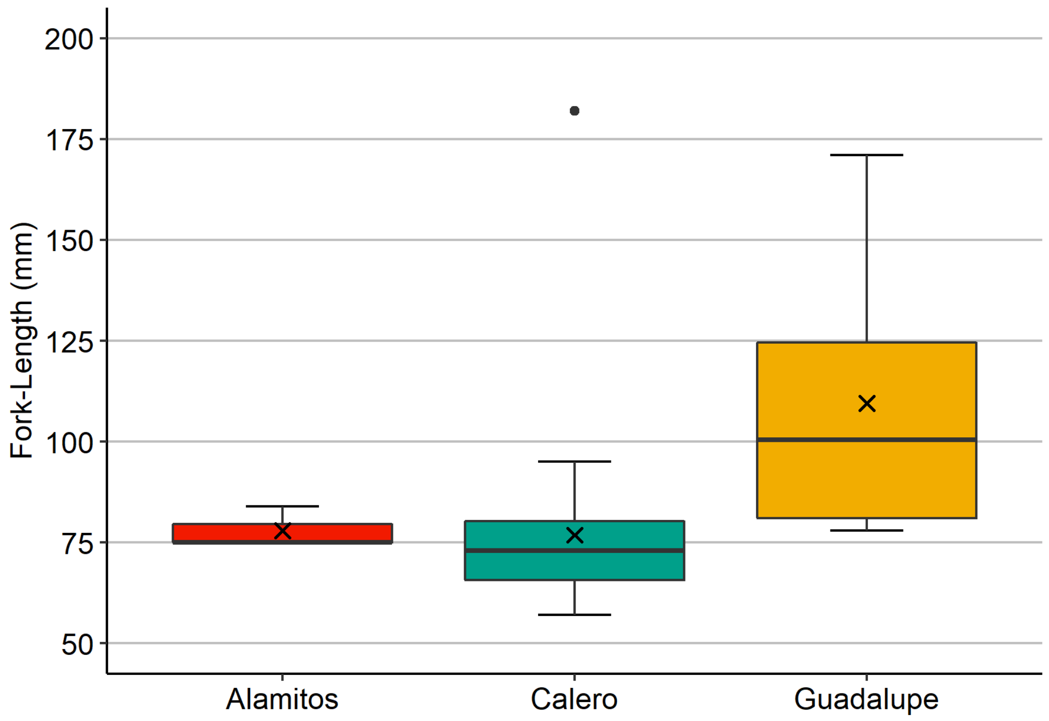

Figure 34. Boxplots (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges, outlying points beyond whiskers, and mean (x)) of *O. mykiss* size distribution (fork-length) for Alamitos, Calero, and Guadalupe Creek sub-watersheds in 2021.

In addition to *O. mykiss* data, information on species composition in the Guadalupe River Watershed, including the presence of non-native fish species, was gathered. Non-native species observed in 2021 included mosquitofish, largemouth bass, green sunfish, and tule perch. Composition of non-native species observed by creek are provided in Figure 35. The most prevalent non-native species collected was largemouth bass, which can be a major predator of juvenile *O. mykiss*. However, all non-native species can impact the habitat and natural communities within the system and have the potential to increase competition for prey and potentially habitat resources when and where there is overlap with *O. mykiss*. Los Gatos Creek had the highest percentage of non-native species detected with over 37% of captured fish being non-native, followed by Alamitos Creek at just over 13%. This differed slightly from 2020 when Guadalupe River had the highest percentage of non-natives, followed by Los Gatos Creek. Looking at the Guadalupe River Watershed as a whole, the overall percentage of non-native fish was less than 5% of all fish observed; this is an increase from 2% in 2020 (Table 41). Of note, non-native fish on Alamitos Creek ranged from <0.01 to 0.6% of the total catch from 2018 to 2020, with an average density of 0.20 and 0.25 *O. mykiss*/m in 2018 and 2019, respectively, dropping to 0.12 *O. mykiss*/m in 2020. In 2021, non-native species made up 13% of the catch, with an average density of 0.02 *O. mykiss*/m. There is no evidence at this time of direct negative impacts to *O. mykiss* as a result of non-native species' presence in the Guadalupe River Watershed. Nonetheless, the effect of non-native species on *O. mykiss* presence and abundance is a factor that should be considered when assessing trends in *O. mykiss* populations in the Guadalupe River Watershed.

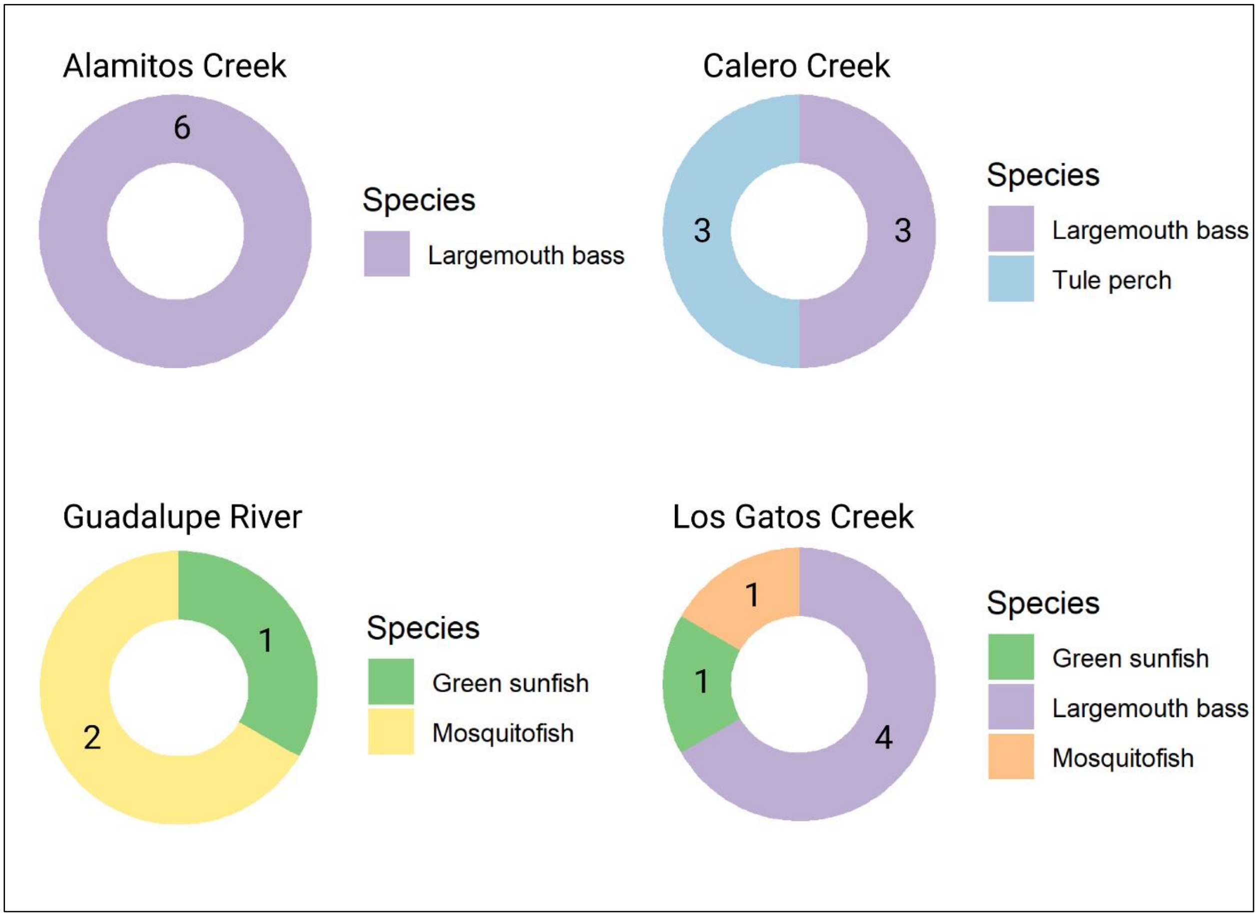

Figure 35. Non-native fish species composition per sub-watershed.

Table 40. Total capture of fish per sub-watershed and percentage of non-native species.

	Guadalupe River	**Guadalupe Creek**	**Los Gatos Creek**	**Alamitos Creek**	**Calero Creek**	**Guadalupe Watershed**
Total Fish Captured	108	253	16	46	77	500
Non-native Fish Captured	3	0	6	6	6	21
Percent Non-native	2.78%	0.00%	37.50%	13.04%	7.79%	4.20%

There are no clear, consistent trends regarding the effects of habitat complexity, water quality parameters, and nonnative species presence on *O. mykiss* populations in the watershed; however, there are clear patterns in terms of the effects of drought conditions. Monitoring in both 2020 and 2021 yielded some of the lowest numbers of *O. mykiss* since the monitoring program began and coincide with the current drought. According to the National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS), majority of the county, including the Guadalupe River Watershed, was categorized as "extreme drought," at the time of sampling in 2021, meaning that water supply was inadequate for agriculture, wildlife, and urban needs and reservoirs were extremely low. They categorize 2021 as the 16th driest year to date over the past 127 years. Similarly, populations of *O. mykiss* in the watershed plummeted during the 2014-2016 drought; in fact, no *O. mykiss* were detected at any wetted sampling location in 2015 and only two were detected in 2016. However, following record-breaking rains in the winter of 2017, *O. mykiss* reappeared and were captured during fall 2017 sampling, highlighting the importance of flow conditions for *O. mykiss* survival and their ability to rebound. Drought can result in reduced water quality and streamflow, which in turn reduces connectivity to suitable habitat, limiting movement and overall habitat availability. Drought conditions can have immediate effects on fish and invertebrate species' abundance, growth, survival, location in the watershed and/or migration capabilities. These effects to aquatic ecosystems may be short-term or long-lasting, depending on the severity and duration of the drought. Continued sampling will help shed light on the effects of the current drought on *O. mykiss* populations within the Guadalupe River Watershed.

Despite varying conditions in each creek sampled in the Guadalupe River Watershed, with the exception of Calero Creek either *O. mykiss* were not present or populations declined throughout the watershed in recent years, yet the fish that are present have been in good condition. Fish condition in the Guadalupe River Watershed was assessed in 2020 (Valley Water 2021b), and the analysis found that the majority of fish were in excellent condition with 83% of fish sampled (excluding fish >200 mm fork-length) falling either within or above the optimal relative weight range, indicating that environmental conditions within the watershed were favorable for supporting the growth and persistence of juvenile *O. mykiss*. This was also the case in 2021 with 92% of fish sampled falling either within or above the optimal relative weight target range (see Appendix B). If multiple populations at small spatial scales are trending in alternate directions, it is likely those populations are being affected by local factors. However, multiple populations showing similar abundance or productivity trends across large spatial scales is indicative of environmental influences occurring at those similarly large spatial scales (Kendall et al. 2017). A 2017 report (CalTrout 2017) ranked the level of concern for the vast majority of salmonids in California as “high” or “critical.” The Napa Resource Conservation District (RCD) estimates the total statewide steelhead population to be around 250,000 adults, which is less than half of the population of the 1990s (Napa RCD 2021). Napa RCD has conducted spring downstream migrant trapping since 2009. Capture of *O. mykiss* measuring less than 130 mm peaked in 2013 at 3,025 individuals. That number has dramatically declined, with a low of one observed in 2019; six were captured in 2020 (Napa RCD 2020). Monitoring at the Pescadero Creek lagoon complex showed that less than 1% of the steelhead captured in 2018 were young-of-year, compared to approximately 10-35% from previous sample years (Jankovitch and Diller 2019). Marin Water showed sharp declines in juvenile *O. mykiss* abundance between 2017 and 2018 (from 2,077 to 1,407). The lowest numbers since 2005 occurred in 2019 and 2020 (at 825 and 841, respectively; Marin Water 2020).

Commercial and recreational ocean salmon fisheries off the coasts of Washington, Oregon, and California have declined substantially since the 1980s (NOAA 2021). Kendall et al. (2017) analyzed anadromous *O. mykiss* smolt-to-adult survival from 48 populations in Washington, Oregon, and British Columbia, and adult abundance from 35 coastal British Columbia and Washington populations. They found that over 80% of these populations have declined in abundance since 1980. Smolt survival data was variable over time but has declined for most populations. This would indicate that factors affecting those *O. mykiss* populations are likely occurring at a larger scale, such as the ocean, compared to specific freshwater stream environments (Kendall et al 2017). Ocean conditions are important to survival and return rates of *O. mykiss*. Because these conditions can vary over time and influence salmonid populations, it is important to understand what is happening in the marine environment when examining trends in anadromous fish populations.

During La Niña, waters off the Pacific coast are colder and contain more nutrients than in other years; this environment is supportive of cold-water species like *O. mykiss*. In contrast, El Niño events describe unusually warm water periods in the Pacific Ocean. Looking at the long-term dataset on the Guadalupe River from 2004 to present, no *O. mykiss* were detected from 2015 to 2018; this is following the strong El Niño event from 2015 to 2016 (NOAA 2021). However, strong La Niña events did not necessarily correlate with increases in *O. mykiss* abundance in the Guadalupe River Watershed in the same timeframe (e.g., 2007 – 2009, 2010 – 2011, 2017 – 2018, 2020 – 2021).

Trends in *O. mykiss* abundance can be difficult to assess due to their plastic life history. Populations are low and variable, and because the expanded monitoring for the Guadalupe River Watershed just began in 2018, additional years of study will be required to better assess trends in abundance and distribution. Juvenile *O. mykiss* continue to persist in the Guadalupe River Watershed, even during the extreme drought conditions our region is currently experiencing, with multiple age classes present. As more data becomes available in the following years a better understanding of fish in the Guadalupe River Watershed will develop.

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Valley Water. 2022. Guadalupe River Watershed *Oncorhynchus mykiss* 2020-2021 Migration Monitoring Using Passive Integrated Transponder Tags.

Appendix A

2020 – 2021 Guadalupe River Watershed Stream Temperature Monitoring

2020-2021

Guadalupe River Watershed Stream Temperature Monitoring

Prepared By:

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January 2022

Contents

Introduction 1
Methods 1
  Monitoring Stations 1
  Temperature Loggers 3
  Logger Deployment 4
  Data Download and Analysis 4
Results and Discussion 6
  Guadalupe River 6
    GUAD1 6
    GUAD2 6
    GUAD3 7
    GUAD4 8
    GUAD5 9
    GUAD6 10
    GUAD7 11
    Guadalupe River Discussion 12
  Guadalupe Creek 13
    GCRK1 13
    GCRK2 14
    GCRK3 15
    GCRK5 16
    GCRK4 17
    Guadalupe Creek Discussion 18
  Alamitos Creek 19
    ALAM1 19
    ALAM5 20
    ALAM6 21
    ALAM2 22
    ALAM3 23
    ALAM4 24
    Alamitos Creek Discussion 25
  Los Gatos Creek 26
    LOSG1 26

LOSG3....27
LOSG2....28
Los Gatos Creek Discussion....29
Calero Creek....30
CALE1....30
CALE3....31
CALE2....32
Calero Creek Discussion....33
Conclusion....34
References....35

Figures

Figure 1. Guadalupe River Watershed stream temperature monitoring stations.....2
Figure 2. Onset HOBO® MX2203 Tidbit temperature logger.....3
Figure 3. Galvanized steel pipe housing for temperature loggers.....4
Figure 4. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD2.....7
Figure 5. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD3.....8
Figure 6. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD4.....9
Figure 7. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD5.....10
Figure 8. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD6.....11
Figure 9. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD7.....12
Figure 10. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK1.....14
Figure 11. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK2.....15
Figure 12. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK3.....16
Figure 13. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK5.....17
Figure 14. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK4.....18
Figure 15. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM1.....20
Figure 16. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM5.....21

Figure 17. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM6. 22
Figure 18. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM2. 23
Figure 19. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM3. 24
Figure 20. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM4. 25
Figure 21. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station LOSG1. 27
Figure 22. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station LOSG3. 28
Figure 23. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station LOSG2. 29
Figure 24. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station CALE1. 31
Figure 25. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station CALE3. 32
Figure 26. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station CALE2. 33

Tables

Table 1. Flow releases from Guadalupe, Almaden, and Calero Reservoirs during Water Year 2021 stream temperature monitoring. 5

Introduction

The 440 square kilometer Guadalupe River Watershed begins in headwater tributaries near the summits of Loma Prieta and Mount Umunhum in the Santa Cruz Mountains, then flows north into the mainstem of the Guadalupe River before draining into South San Francisco Bay through Alviso Slough. These upper watershed areas are developed to a lesser extent, with a lower degree of anthropogenic disturbance. The northern and eastern portions of the watershed are comprised of the Santa Clara County valley floor. Portions of the valley floor are extensively urbanized with patches of undeveloped parks and open agricultural lands. Major tributaries in the Guadalupe River Watershed include Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek.

The Guadalupe River Watershed supports the federally threatened Central California Coast steelhead (*Oncorhynchus mykiss, O. mykiss*) distinct population segment in 5 of its systems: Guadalupe River, Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek. Furthermore, there is designated critical habitat in the portion of the Guadalupe River between its confluence with San Francisco Bay and West Hedding Street in San Jose (70 FR 52570, September 2005).

Stream temperature is an important factor affecting the abundance and distribution of *O. mykiss.* To provide continuous monitoring of temperature conditions and help assess *O. mykiss* habitat suitability within the Guadalupe River Watershed, Valley Water conducts year-round temperature monitoring throughout the Guadalupe River, Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek. This report summarizes the stream temperature data collected in these systems for Water Year 2021 (Oct. 1, 2020−Sept. 30, 2021).

Methods

Monitoring Stations

Stream temperatures were monitored at twenty-four monitoring stations on *O. mykiss* streams throughout the Guadalupe River Watershed (Figure 1). These stations were selected as they are within areas where *O. mykiss* migration, spawning, and/or rearing is expected to occur. Station locations are subject to change and additional stations may be established as monitoring efforts continue and management objectives are modified.

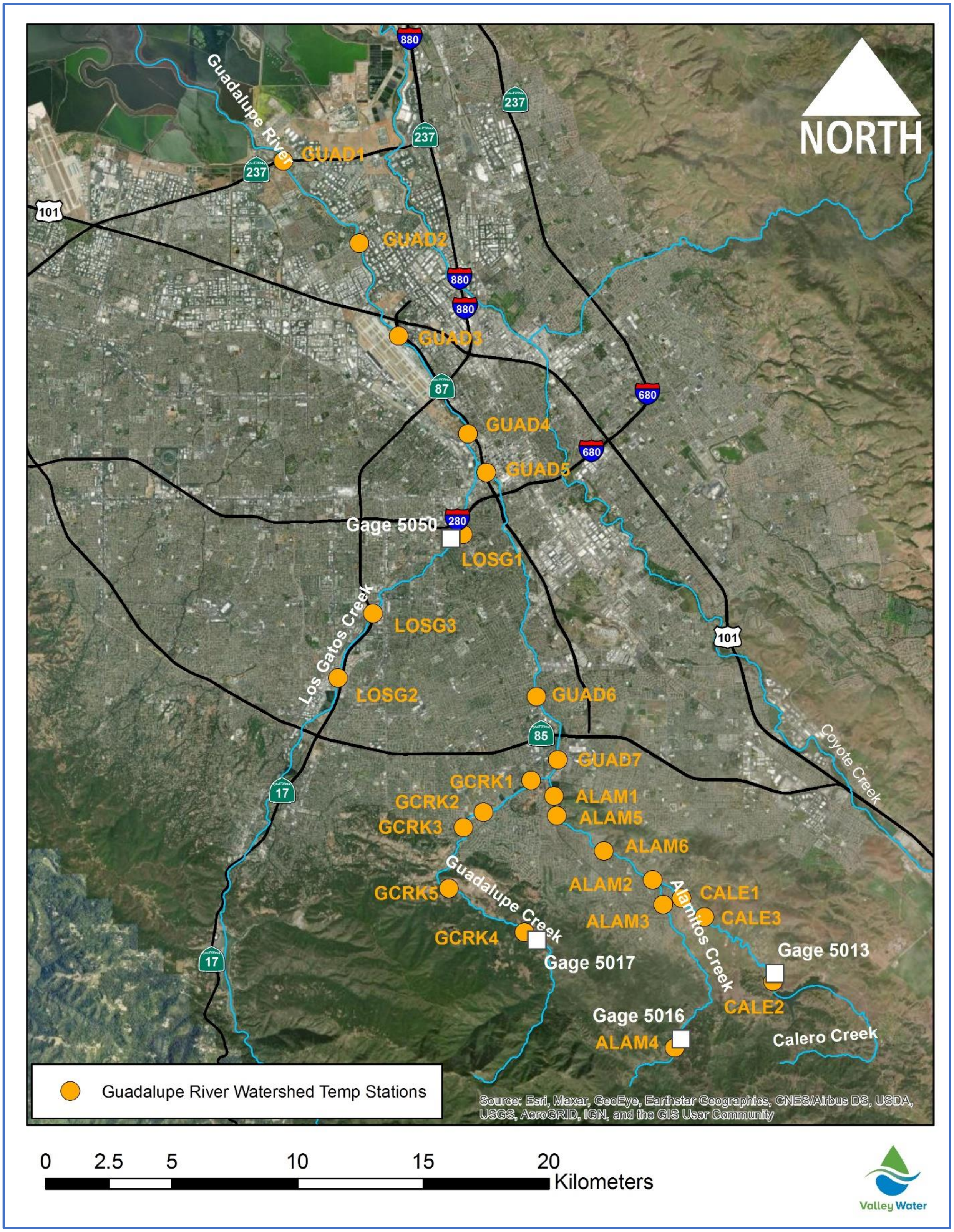

Figure 1. Guadalupe River Watershed stream temperature monitoring stations.

Temperature Loggers

Temperatures were recorded using Bluetooth-capable Onset HOBO® MX2203 Tidbit Temperature Loggers (herein referred to as logger(s)) (Figure 2). The loggers measured 4.45 x 7.32 x 3.58 cm, weighed 36.2 g, and had an accuracy of ±0.25°C with a resolution of 0.01°C. Using the Onset HOBO® mobile application from a smartphone, each logger was programmed to collect data at a 1-hour sampling rate and to start recording on the hour interval (e.g., 1:00PM, 2:00PM) following the deployment time.

Each logger was housed in an 11.5 cm x 4.3 cm galvanized steel pipe fitted with a cap at each end (Figure 3). The pipe had four 1.5 cm-diameter holes on the sides and a single hole on each of the caps to allow water to flow through the housing. In addition to providing protection and to shield the loggers from direct sunlight, the housing was also used to weigh down the logger, which helped ensure that it maintained contact with the streambed and thus remained submerged.

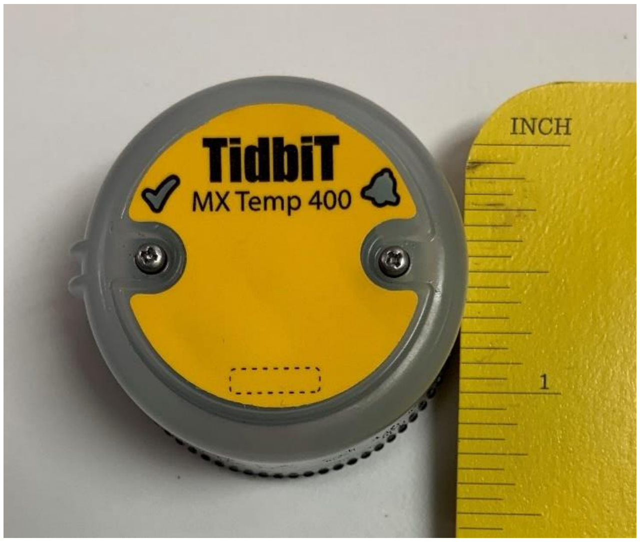

Figure 2. Onset HOBO® MX2203 Tidbit temperature logger.

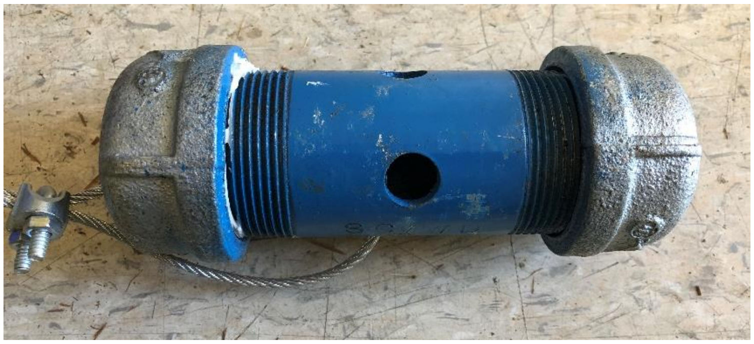

Figure 3. Galvanized steel pipe housing for temperature loggers.

Logger Deployment

The housings (with logger inside) were attached using wire clips to a steel cable that was anchored to a stake or natural feature (e.g., tree trunk, root) along the bank of the channel. Loggers were placed in pools whenever possible to help ensure that they would stay submerged during summer low flows. One logger was deployed at each monitoring station.

Data Download and Analysis

The temperature data was downloaded in the field onto a smartphone using the Onset HOBO® mobile application. Once downloaded, data was transferred to the internal Valley Water network and visually inspected for any erroneous temperature readings that may have resulted from either logger malfunction or the logger not being submerged in water. The loggers also had a water detection capability that recorded when the logger was “in” versus “out” of the water. This function was useful during the initial data evaluation to help differentiate between water temperature and air temperature recordings. Anomalous data was clipped from the dataset before further analysis.

Temperature data was analyzed for Water Year 2021 (Oct. 1, 2020−Sept. 30, 2021). Some loggers had obtainable data for the entire Water Year; however, others were missing data due to issues associated with system malfunctions or tampering (removal from water and theft). In those cases, stream temperature was analyzed for the time period in which data was available within the Water Year. For each monitoring station, daily averages, minimums, and maximums were calculated, as well as the 7-day moving average to smooth out daily fluctuations and highlight trends. The 7-day moving average was calculated for each day as the average stream temperature observed for the last 7 days (that day plus the 6 consecutive prior days). In addition, maximum weekly average temperature (MWAT) was determined for each station and computed as the maximum value of the 7-day moving average of daily mean stream temperature.

Release rates from Guadalupe, Almaden, and Calero Reservoirs during Water Year 2021 stream temperature monitoring were retrieved from the Valley Water Surface Data Portal (Table 1). Lexington Reservoir (on Los Gatos Creek) was not included in this analysis as flow from this reservoir is muted and interrupted by another reservoir and other water supply infrastructure. Flow data from Los Gatos Creek at Lincoln Ave (Stream Gage 5050) is included as it is the best representation of flows in the study area. Stream gage information for each creek was considered when interpreting the results of the temperature data analysis.

Table 1. Flow releases from Guadalupe, Almaden, and Calero Reservoirs during Water Year 2021 stream temperature monitoring[1].

Reservoir	**Gage Station**	**Receiving Creek**	**Temp. Monitoring Period**	**Release Rate (cfs)**
Guadalupe	5017	Guadalupe Creek	Oct. 1, 2020 – Sept. 30, 2021	0.5-13.2
Almaden	5016	Alamitos Creek	Oct. 1, 2020 – Sept. 30, 2021	0.7-19.6
Calero	5013	Calero Creek	Oct. 1, 2020 – Sept. 30, 2021	0.5-58
n/a	5050	Los Gatos Creek	Oct. 1, 2020 – Sept. 30, 2021	0.0-707.0

[1] Flow data was retrieved from the following stream gages: 5017=Guadalupe Creek below Guadalupe Reservoir; 5016=Alamitos Creek below Almaden Reservoir; 5013=Calero Creek below Calero Reservoir; 5050=Los Gatos Creek at Lincoln Avenue. See Figure 1 for locations.

Results and Discussion

The following section summarizes the temperature monitoring results by system and includes a brief discussion for each. Results are presented in order from most downstream station to most upstream station.

Guadalupe River

GUAD1

Station GUAD1 is the most downstream monitoring station on the Guadalupe River and was originally located approximately 0.8 km upstream of Salt Pond A8 under Highway 237 in Alviso. Due to a combination of tampering by the public and logger malfunctions, the 2020-2021 dataset for GUAD1 was very sparse and thus not included in this report. The station has since been relocated to a more discrete area approximately 1.4 km upstream to try to prevent future tampering.

GUAD2

Station GUAD2 is located upstream of GUAD1 and approximately 30 m downstream of Montague Expressway in North San Jose. Temperature data for the logger is only available for up to September 3, 2021 due to a malfunction with the logger. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 4. Between October 1, 2020 and September 3, 2021, stream temperatures ranged from 8.1 to 23.2°C with an average daily fluctuation of 1.3°C. The MWAT for station GUAD2 during the monitoring period was 21.4°C.

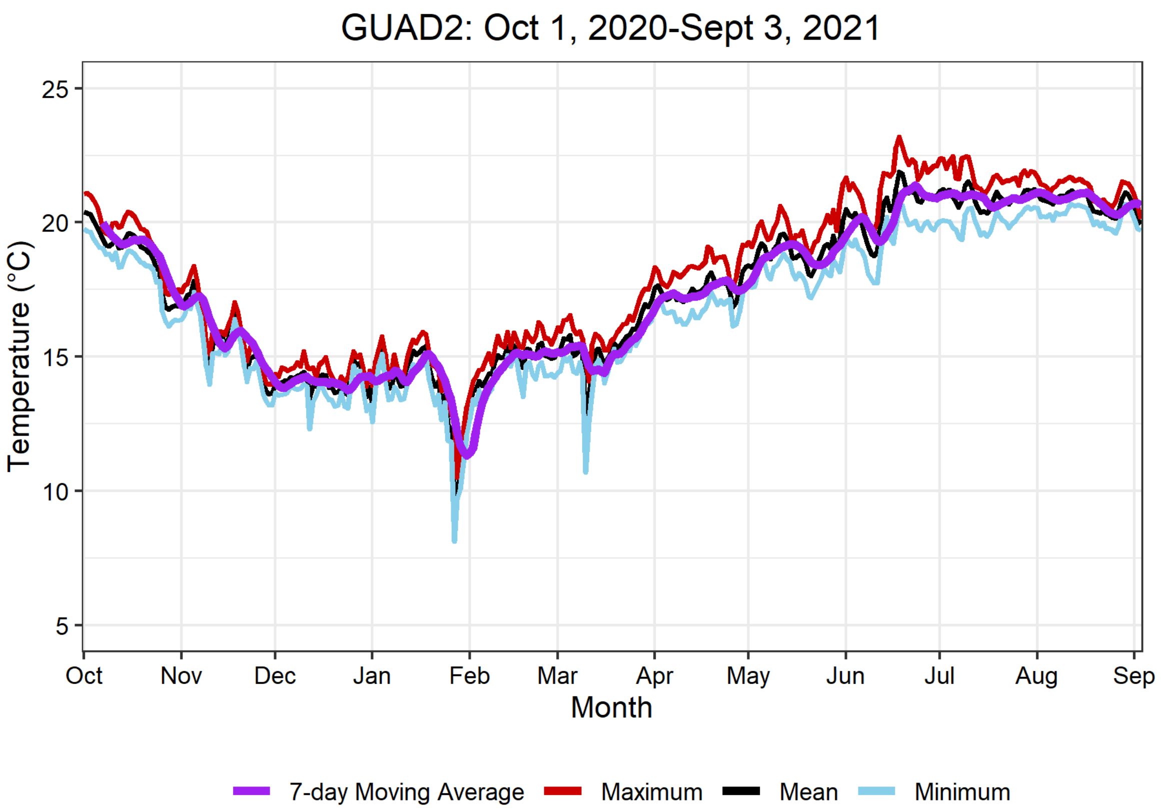

Figure 4. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD2.

GUAD3

Station GUAD3 is located upstream of GUAD2 and approximately 150 m upstream of Airport Parkway in San Jose. This station is roughly 1,000 ft downstream of 2021 *O. mykiss* juvenile rearing monitoring site GRBONUS (see Valley Water 2022). Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 5. In Water Year 2021, stream temperatures ranged from 6.6 to 22.4°C with an average daily fluctuation of 1.6°C. The MWAT for station GUAD3 during the monitoring period was 20.7°C.

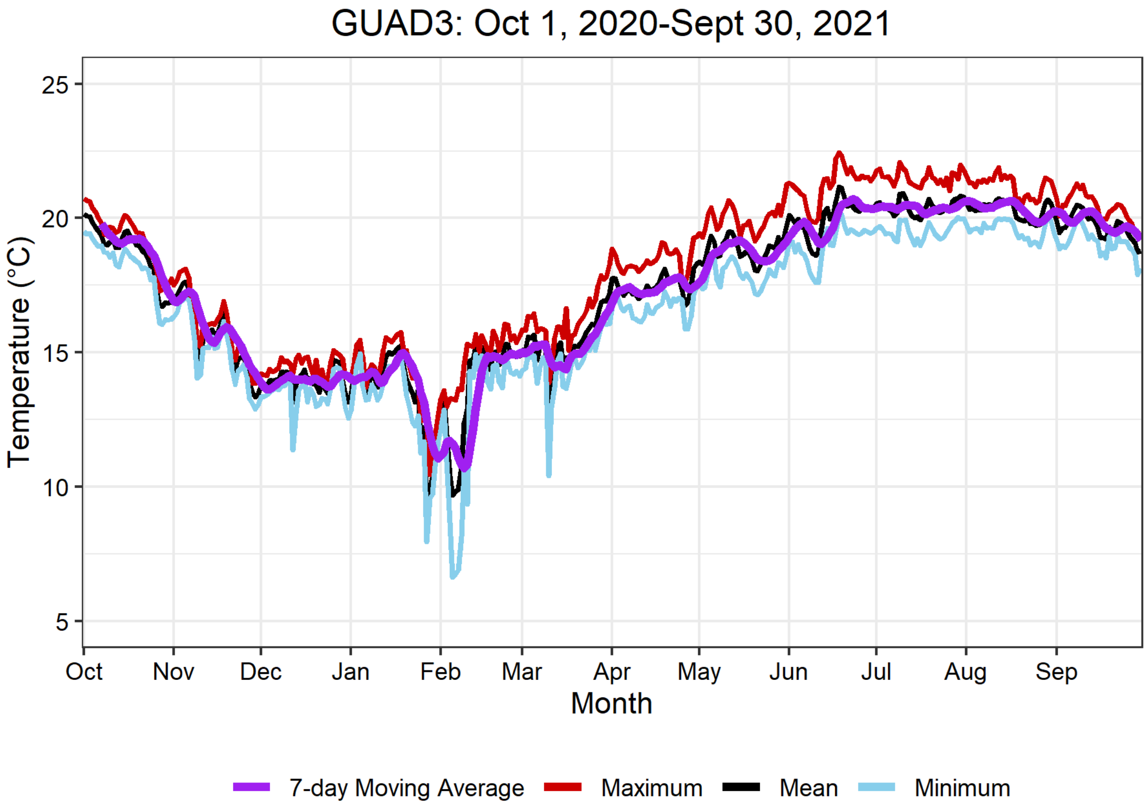

Figure 5. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD3.

GUAD4

Station GUAD4 is located upstream of GUAD3 and approximately 30 m downstream of Coleman Avenue in San Jose. This station is roughly 200 ft upstream of *O. mykiss* juvenile rearing monitoring site GR002 (see Valley Water 2022). The logger stopped logging on May 25, 2021 due to a malfunction and was reconfigured on July 14, 2021. Temperature data is only available up to August 15, 2021, as the logger was no longer submerged after this date. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 6. Between October 1, 2020 and August 15, 2021, stream temperatures ranged from 7.8 to 22.9°C with an average daily fluctuation of 1.4°C. The MWAT for station GUAD4 during the monitoring period was 21.3°C.

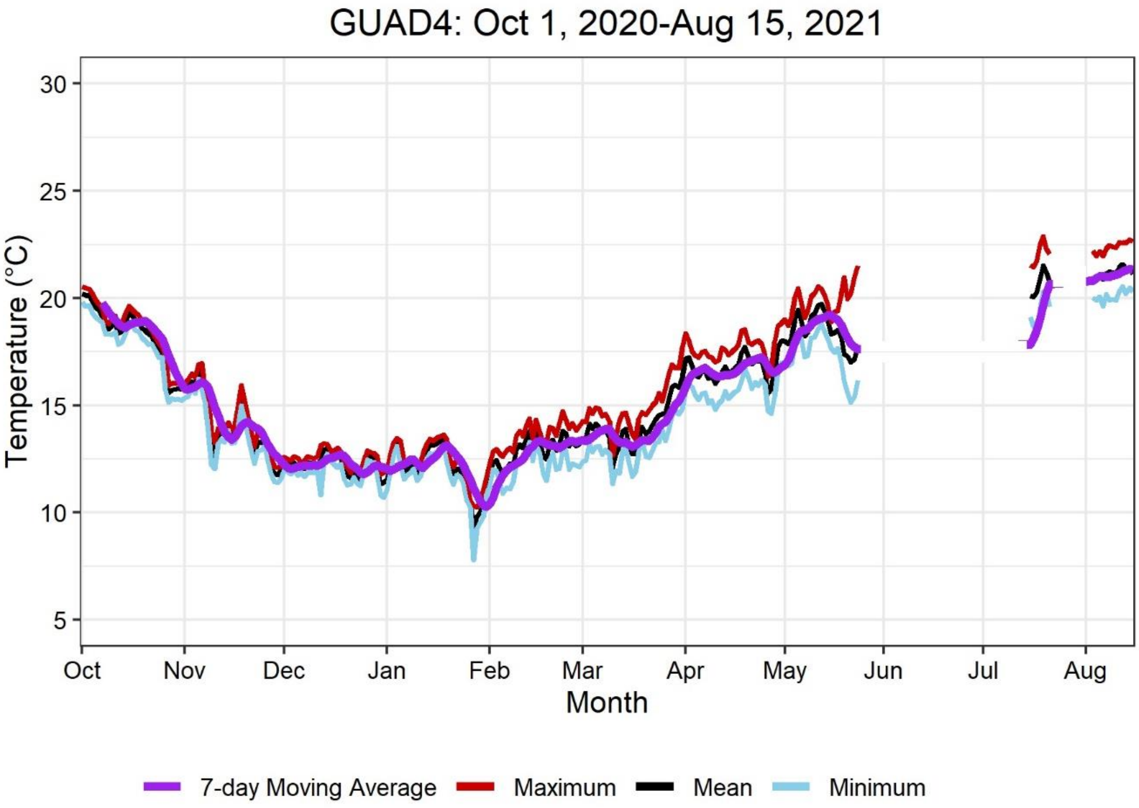

Figure 6. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD4.

GUAD5

Station GUAD5 is located upstream of GUAD4 and was originally about 60 m downstream of West Santa Clara Street in downtown San Jose. Due to repeated tampering by the public, GUAD5 was moved to a more hidden location approximately 180 m downstream. This station is now located within *O. mykiss* juvenile rearing monitoring site GR003 (see Valley Water 2022). Temperature data is only available from January 4, 2021 to April 7, 2021. The logger was missing (presumably lost or stolen) at the time of data retrieval on January 4, 2021 and replaced with a new one, but it was then discovered missing again following the spring downloads. A new logger was redeployed at its current location after the end of Water Year 2021. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 7. Between January 4, 2021 and April 7, 2021, stream temperatures ranged from 7.8 to 21.5°C with an average daily fluctuation of 3.4°C. The MWAT for station GUAD4 during the monitoring period was 17.4°C.

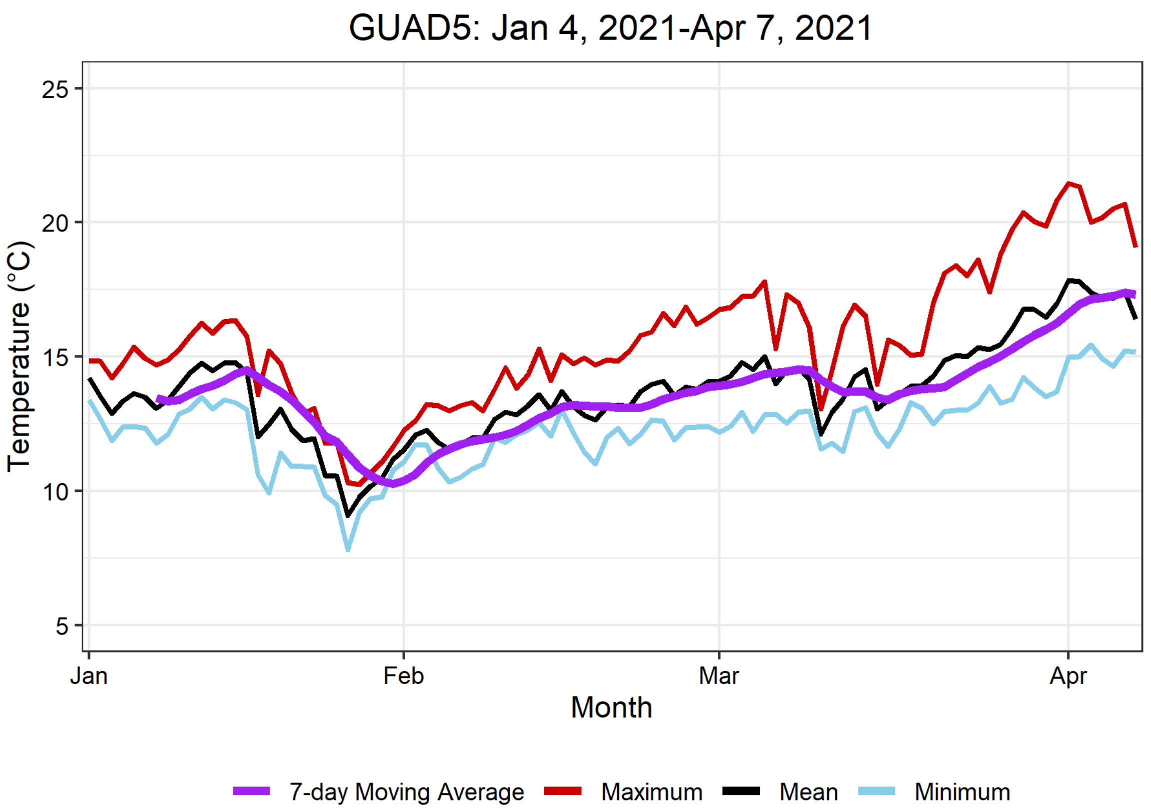

Figure 7. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD5.

GUAD6

Station GUAD6 is located upstream of GUAD5 and approximately 300 m downstream of Branham Lane in San Jose. Temperature data for this logger is not available after April 9, 2021 due to extreme drought-induced dry back. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 8. Between October 1, 2020 and April 9, 2021, stream temperatures ranged from 6.3 to 22.8°C with an average daily fluctuation of 1.7°C. The MWAT for station GUAD6 during the monitoring period was 21.1°C.

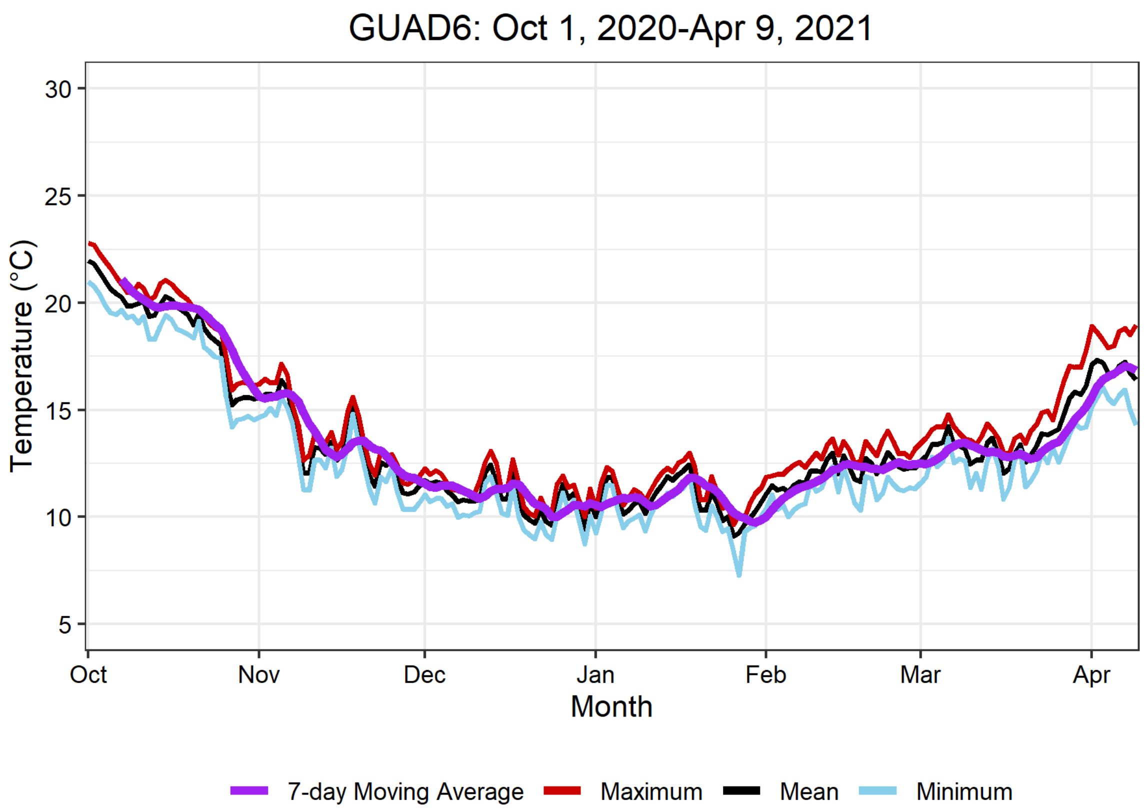

Figure 8. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD6.

GUAD7

Station GUAD7 is the most upstream monitoring station and is located approximately 60 m upstream of Blossom Hill Road and 0.8 km downstream of Almaden Lake in San Jose. Temperature data for this logger is not available after June 18, 2021 due to drought-induced dry back. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 9. Between October 1, 2020 and June 18, 2021, stream temperatures ranged from 9.3 to 27.4°C with an average daily fluctuation of 2.6°C. The MWAT for station GUAD7 during the monitoring period was 23.3°C.

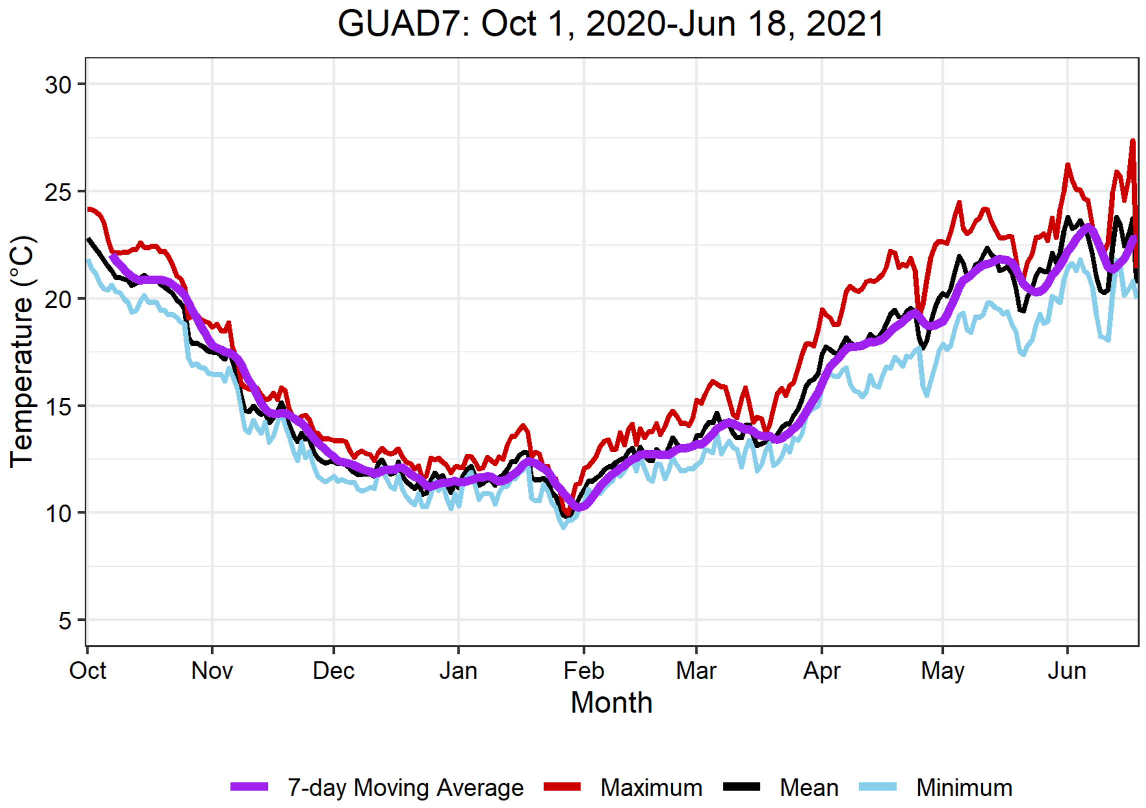

Figure 9. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GUAD7.

Guadalupe River Discussion

Stations with data for all or most of the Water Year showed a similar trend where temperatures decreased from the beginning of the Water Year until the end of January, increased up to mid-August, then plateaued or somewhat decreased until the end of the Water Year. Stations with limited data also displayed these trends for the time periods in which data was available. However, the rate of change differed slightly among stations. This general temperature trend is considered typical for the region.

No clear temperature pattern was detected along the length of the Guadalupe River as temperature conditions at the most downstream station with available data (GUAD2) were similar to those at some of the more upstream stations (GUAD4−GUAD7). Direct comparisons of daily fluctuations and MWATs cannot reliably be made since the timeframe for available data varied from station to station; however, there was one notable observation. All stations had a noticeable dip in temperature at the end of January, though it was more pronounced at the downstream monitoring stations (GUAD2 and GUAD3). This dip in temperature corresponds with the only storm event of the season when flows reached over 2000 cubic feet per second (cfs) on portions of the Guadalupe River.

Across all monitoring stations, daily ranges were greatest in the spring and summer months with large variations present between daily minimum and maximum temperatures. This trend was most pronounced at monitoring station GUAD7. These large diurnal fluctuations were also present during the previous water year (see Valley Water 2021) and therefore may be a normal pattern in this system in the warmer months. We will be able to form a more definitive conclusion as data continues to be collected over the next several years.

Guadalupe Creek

GCRK1

Station GCRK1 is the most downstream monitoring station on Guadalupe Creek and is located approximately 9 m upstream of Almaden Expressway in San Jose. This station is roughly 1 km downstream of *O. mykiss* juvenile rearing monitoring site GC001 (see Valley Water 2022). Temperature data is only available up to April 1, 2021 as the creek was dry due to extreme drought conditions at GCRK1 after this date. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 10. Between October 1, 2020 and April 1, 2021, stream temperatures ranged from 7.0 to 22.4°C with an average daily fluctuation of 2.5°C. The MWAT for station GCRK1 during the monitoring period was 20.1°C.

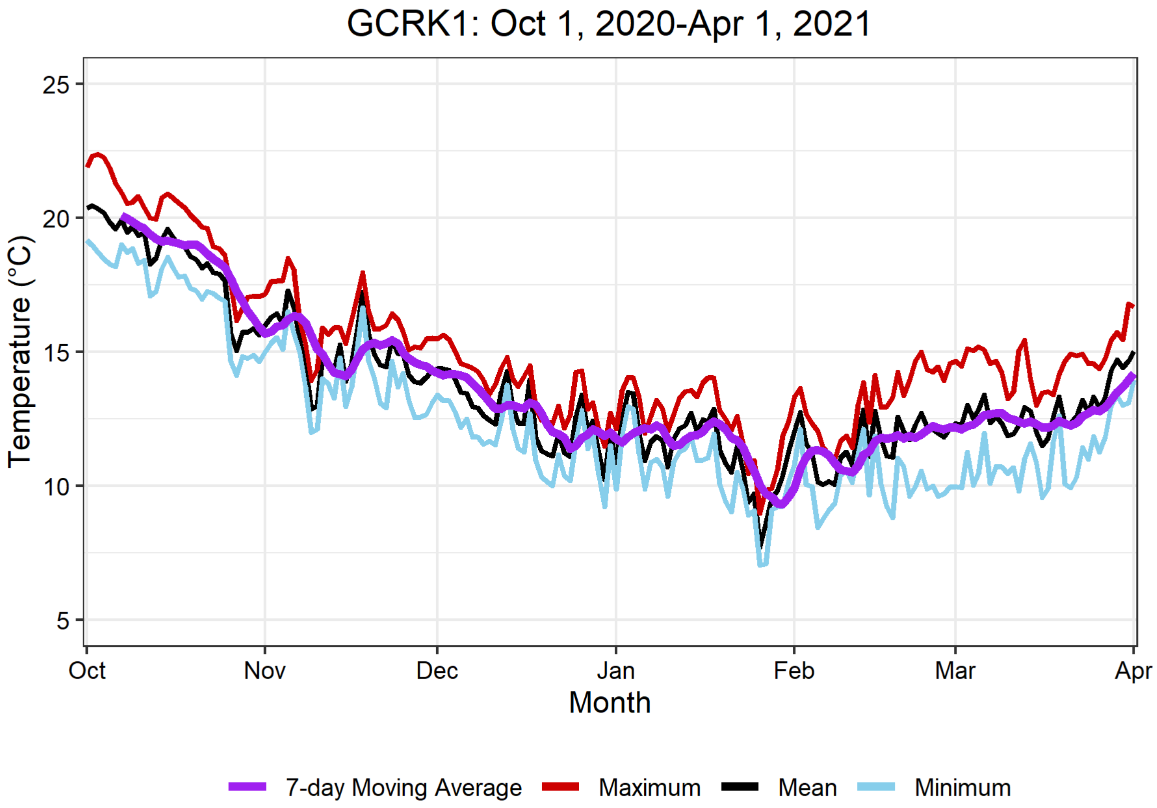

Figure 10. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK1.

GCRK2

Station GCRK2 is located upstream of GCRK1 and approximately 1 km upstream of Meridian Avenue next to the Los Capitancillos percolation ponds in San Jose. This station is immediately upstream of *O. mykiss* juvenile rearing monitoring site GC002 (see Valley Water 2022). Temperature data for Water Year 2021 was only available from January 15, 2021 to March 31, 2021. The logger was discovered missing on September 22, 2020, and due to extreme drought conditions, the creek was dry at this location at the time. A new logger was not deployed until January 2021 when flows returned. However, by the end of March the creek was once again dry at this site. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 11. Between January 15, 2021 and March 31, 2021, stream temperatures ranged from 5.7 to 16.8°C with an average daily fluctuation of 2.2°C. The MWAT for station GCRK2 during the monitoring period was 13.0°C.

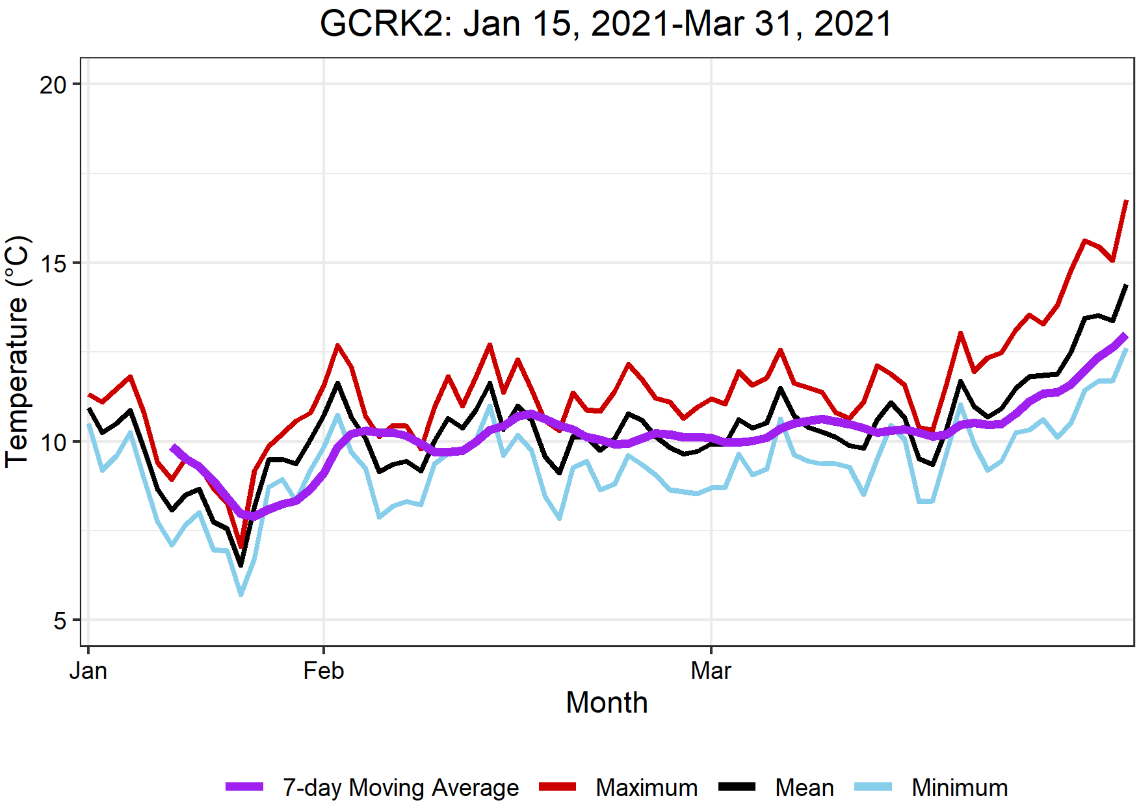

Figure 11. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK2.

GCRK3

Station GCRK3 is located upstream of GCRK2 and approximately 300 m downstream of Coleman Road in San Jose. This station is immediately upstream of *O. mykiss* juvenile rearing monitoring site GC003 (see Valley Water 2022). Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 12. In Water Year 2021, stream temperatures ranged from 5.3 to 20.9°C with an average daily fluctuation of 1.8°C. The MWAT for station GCRK3 during the monitoring period was 19.4°C.

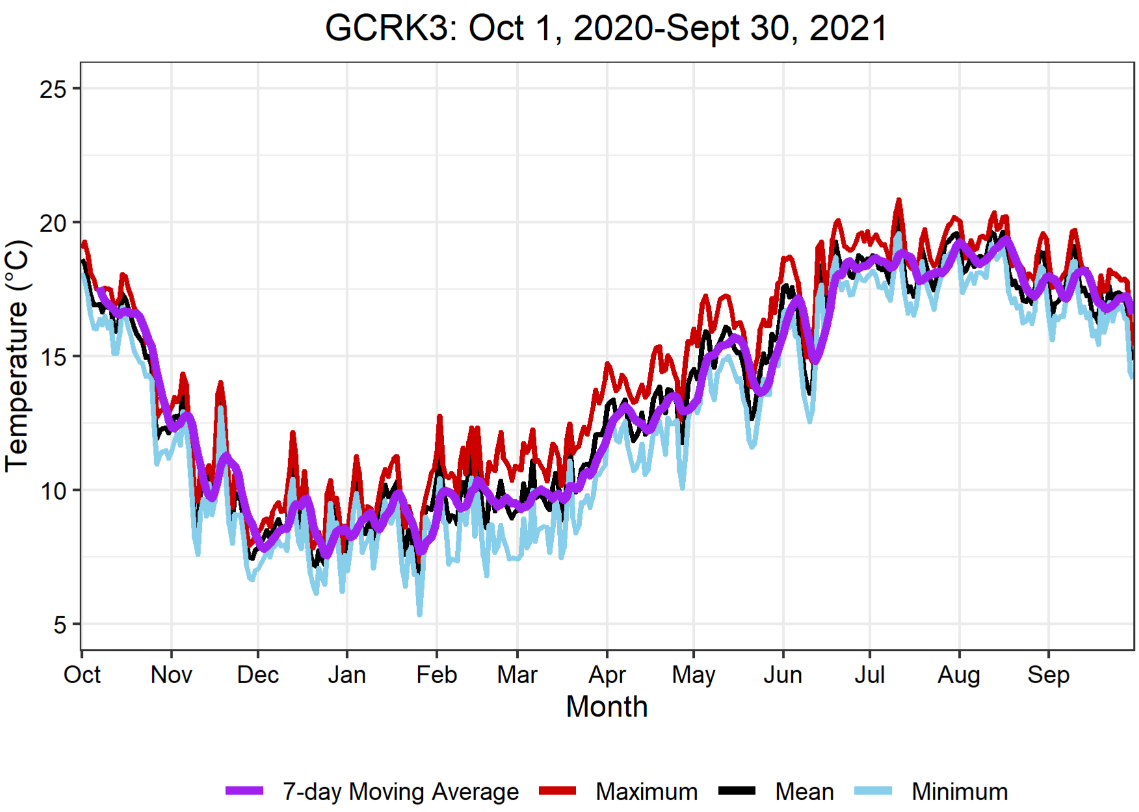

Figure 12. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK3.

GCRK5

Station GCRK5 is located upstream of GCRK3 and approximately 215 m upstream of Guadalupe Creek's confluence with Pheasant Creek. This station is within *O. mykiss* juvenile rearing monitoring reach GC005 (see Valley Water 2022). Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 13. In Water Year 2021, stream temperatures ranged from 5.3 to 21.2°C with an average daily fluctuation of 3.0°C. The MWAT for station GCRK5 during the monitoring period was 19.2°C.

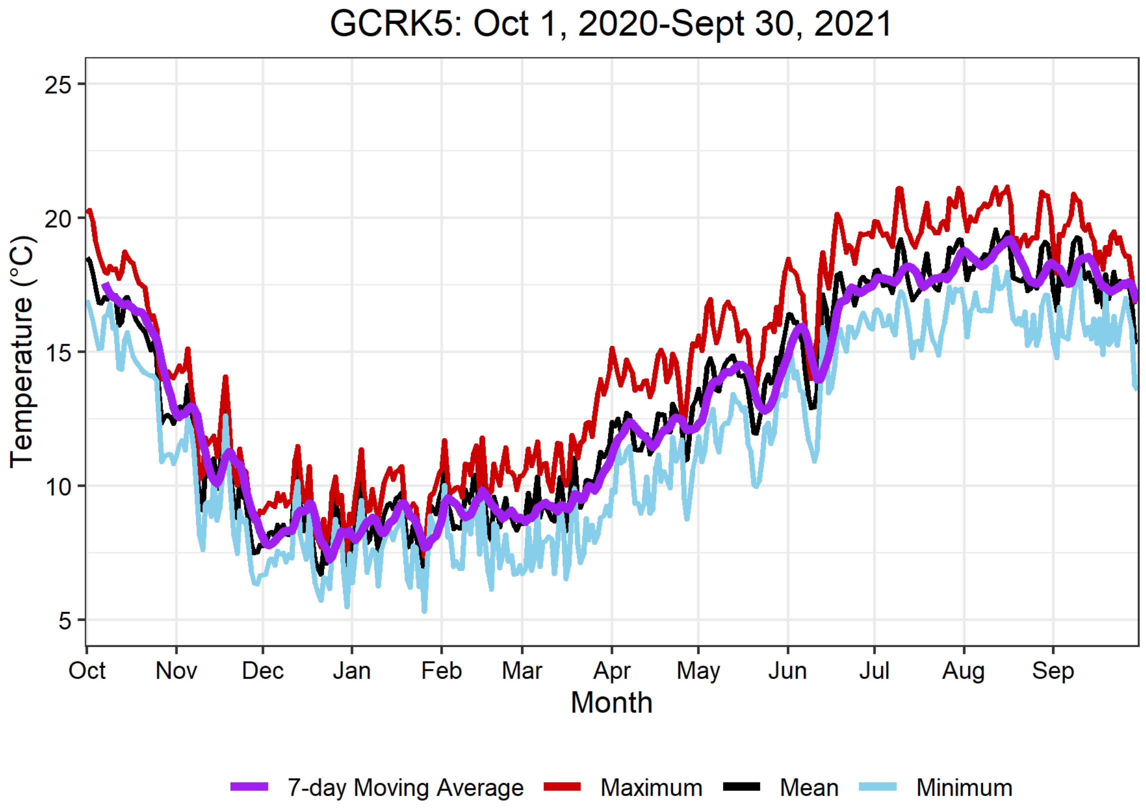

Figure 13. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK5.

GCRK4

Station GCRK4 is the most upstream monitoring station on Guadalupe Creek and is approximately 90 m downstream of the Guadalupe Reservoir outlet. The logger at this station was discovered missing on April 13, 2021 from what appeared to be a corroded cable, and a new one was deployed on that date. Because of this, temperature data is missing for the first few months of Water Year 2021. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 14. Between April 13, 2021 and September 30, 2021, stream temperatures ranged from 10.8 to 22.7°C with an average daily fluctuation of 1.2°C. The MWAT for station GCRK4 during the monitoring period was 21.9°C.

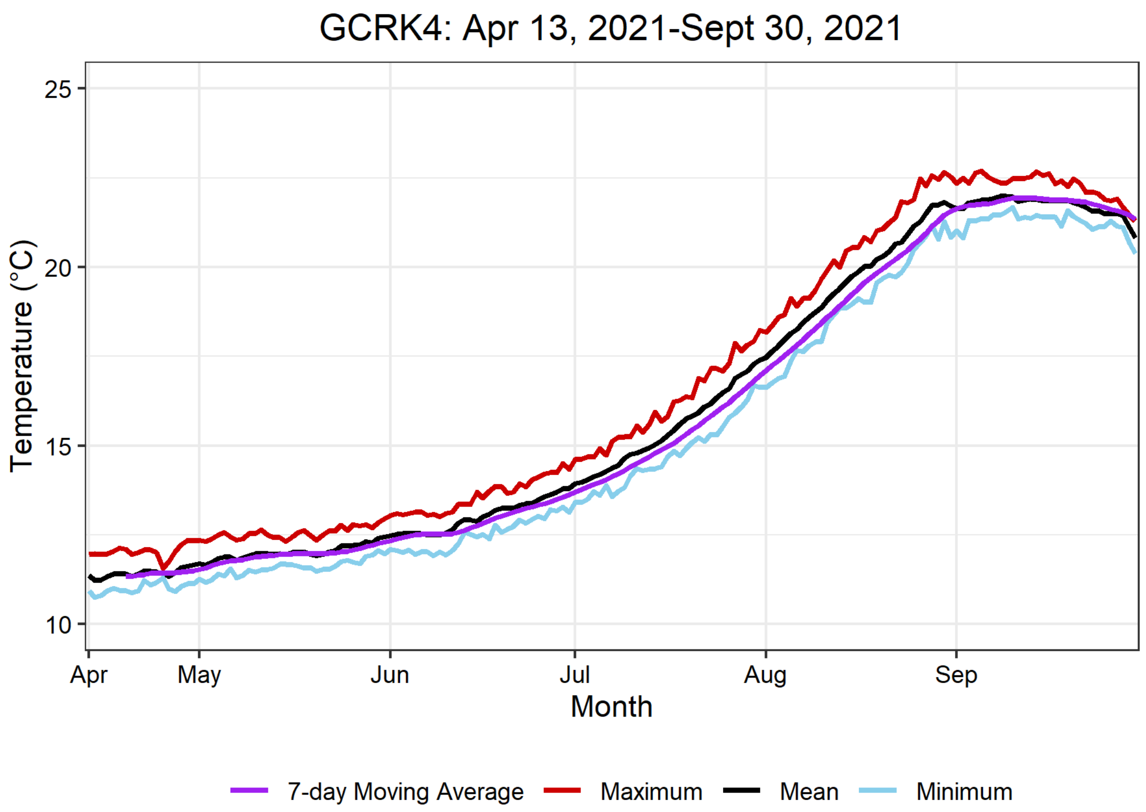

Figure 14. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station GCRK4.

Guadalupe Creek Discussion

Like the Guadalupe River, stations with data for all or most of the Water Year showed a similar trend where temperatures decreased from the beginning of the Water Year to the end of January, increased until mid/end of August, then started to decline until the end of the Water Year, with the rate of change differing slightly among stations. Stations with limited data also displayed these trends for the time periods in which data was available. In addition, stations on Guadalupe Creek also displayed a dip in temperature at the end of January that corresponds with the large storm event. However, this temperature decrease was not as pronounced in Guadalupe Creek as it was in the Guadalupe River.

An interesting temperature pattern was observed along Guadalupe Creek in Water Year 2021. Generally, stream temperatures increase moving downstream during the summer. However, during the hottest portion of the summer with very low releases coming from Guadalupe

Reservoir, the temperature decreased going from GCRK4 to GCRK5. Thermal suitability at GCRK5 was much better than expected, given the circumstances.

GCRK4 (most upstream) showed much lower daily variation than the other stations, but this result is to be expected due to its proximity to the outlet of Guadalupe Reservoir. Guadalupe Reservoir is a bottom release reservoir, and as a result of the thermal buffering caused by the reservoir pool, water is released that is more consistent in temperature.

For the monitoring stations that had data available for the full Water Year (GCRK3 and GCRK5), daily ranges were greatest in the spring and summer months with larger variations present between daily minimum and maximum temperatures. This trend was most pronounced at monitoring station GCRK5. These large diurnal fluctuations were also present during the previous water year (see Valley Water 2021) and therefore may be a normal pattern in this system in the warmer months. We will be able to form a more definitive conclusion as data continues to be collected over the next several years.

Alamitos Creek

ALAM1

Station ALAM1 is the most downstream monitoring station on Alamitos Creek and is located approximately 150 m upstream of Almaden Lake in San Jose. Temperature data for this logger is not available after August 1, 2021 due to drought-induced dry back. In addition, data is unavailable between May 3 and July 5, 2021. The logger was pulled out of the water by the public, and a new one was deployed on July 6, 2021. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 15. From October 1, 2020 to August 1, 2021, stream temperatures ranged from 7.5 to 25.0°C with an average daily fluctuation of 2.8°C. The MWAT for station ALAM1 during the monitoring period was 21.8°C.

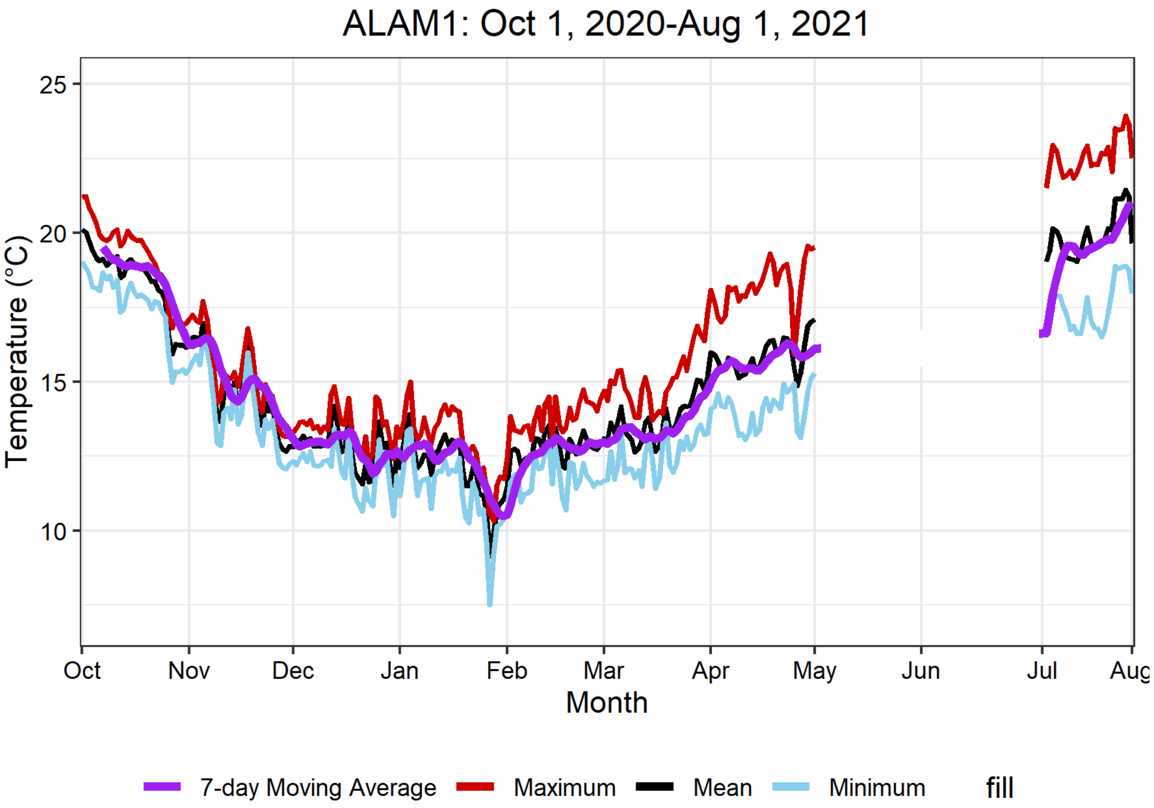

Figure 15. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM1.

ALAM5

Station ALAM5 is located upstream of ALAM1 and approximately 120 m upstream of Mazzone Drive in San Jose. Temperature data for this logger is not available after July 4, 2021 due to drought-induced dry back. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 16. Between October 1, 2020 and July 4, 2021, stream temperatures ranged from 7.6 to 28.1°C with an average daily fluctuation of 3.3°C. The MWAT for station ALAM5 during the monitoring period was 22.4°C.

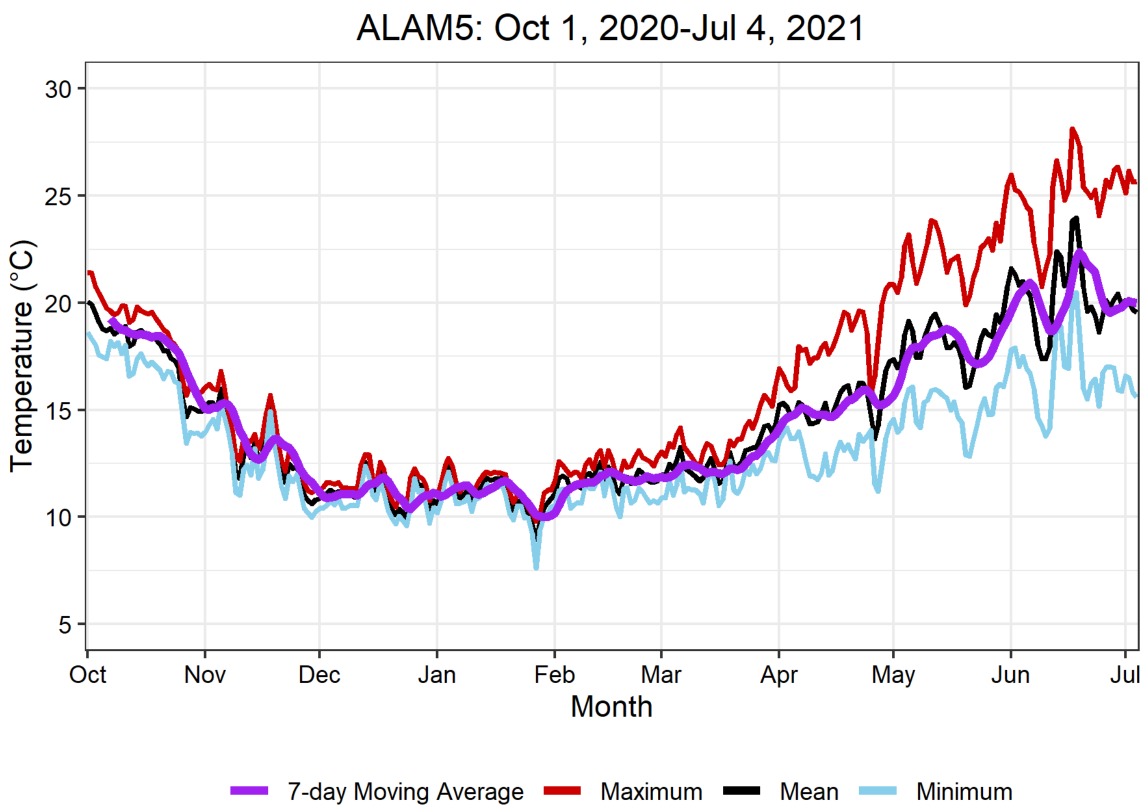

Figure 16. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM5.

ALAM6

Station ALAM6 is located upstream of ALAM5 and approximately 215 m downstream of Graystone Lane in San Jose. This station is roughly 0.4 km downstream of *O. mykiss* juvenile rearing monitoring site AC002 (see Valley Water 2022). Temperature data for this logger is not available after July 12, 2021 due to drought-induced dry back. Additionally, temperature data is not available between December 29, 2020 and January 17, 2021 due to a logger malfunction. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 17. Between October 1, 2020 and July 12, 2021, stream temperatures ranged from 7.5 to 27.3°C with an average daily fluctuation of 3.2°C. The MWAT for station ALAM6 during the monitoring period was 22.2°C.

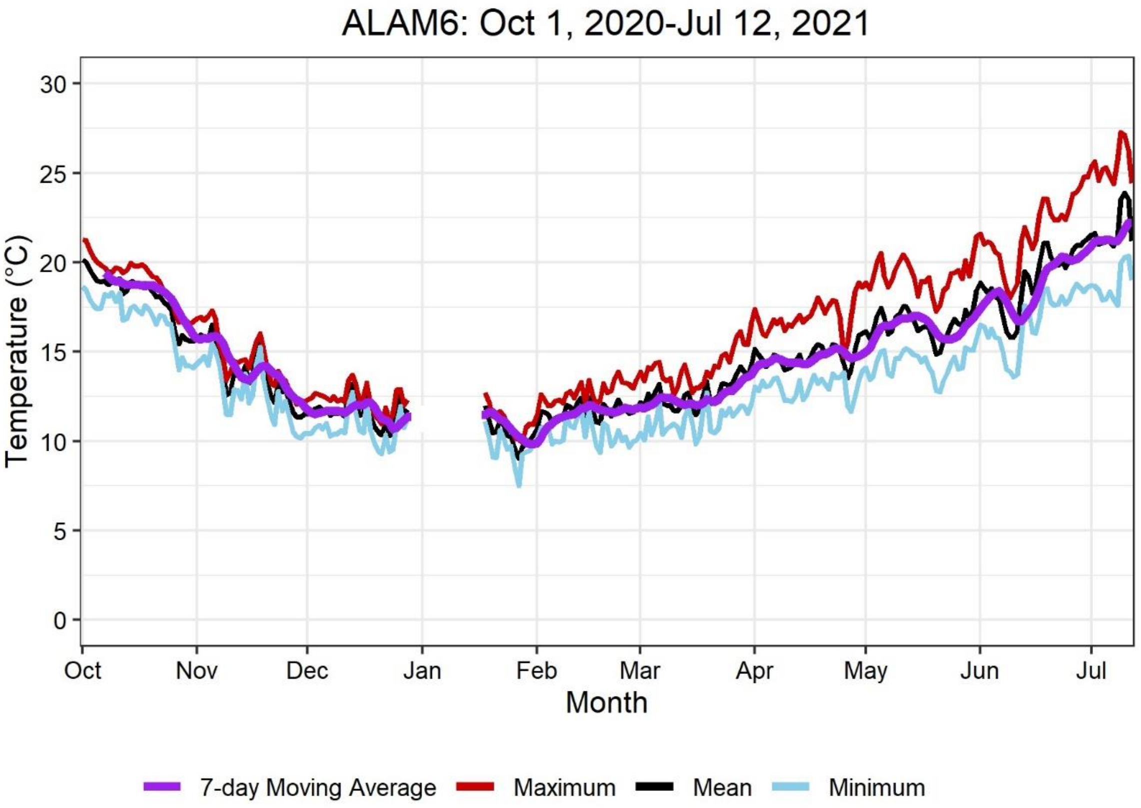

Figure 17. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM6.

ALAM2

Station ALAM2 is located upstream of ALAM6 and approximately 300 m downstream of Alamitos Creek's confluence with Calero Creek. This station is also located within Valley Water's 2021 *O. mykiss* juvenile rearing monitoring site ACBONUS (see Valley Water 2022). Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 18. In Water Year 2021, stream temperatures ranged from 8.0 to 21.9°C with an average daily fluctuation of 2.4°C. The MWAT for station ALAM2 during the monitoring period was 19.6°C.

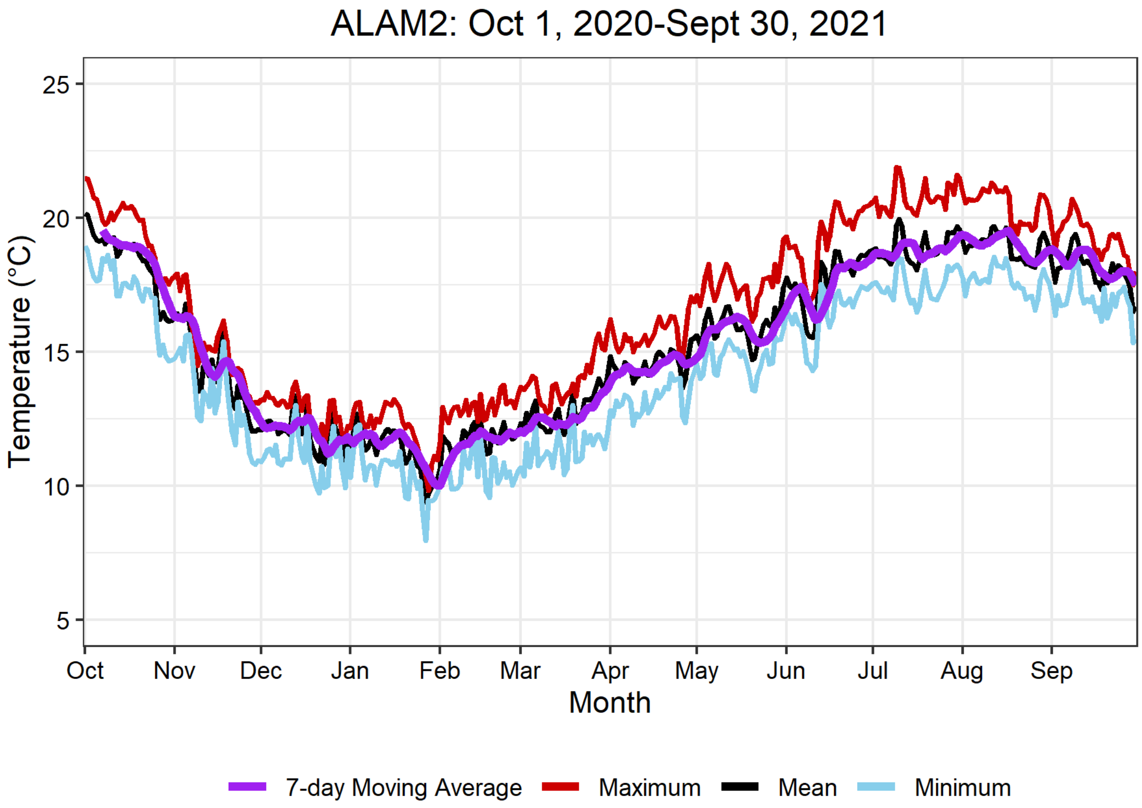

Figure 18. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM2.

ALAM3

Station ALAM3 is located upstream of ALAM2 and approximately 0.4 km upstream of Camden Avenue in South San Jose. This station is roughly 150 m downstream of *O. mykiss* juvenile rearing monitoring site AC003 (see Valley Water 2022). Temperature data for this logger is not available after June 17, 2021 due to drought-induced dry back. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 19. Between October 1, 2020 and June 17, 2021, stream temperatures ranged from 5.1 to 26.2°C with an average daily fluctuation of 4.4°C. The MWAT for station ALAM3 during the monitoring period was 20.0°C.

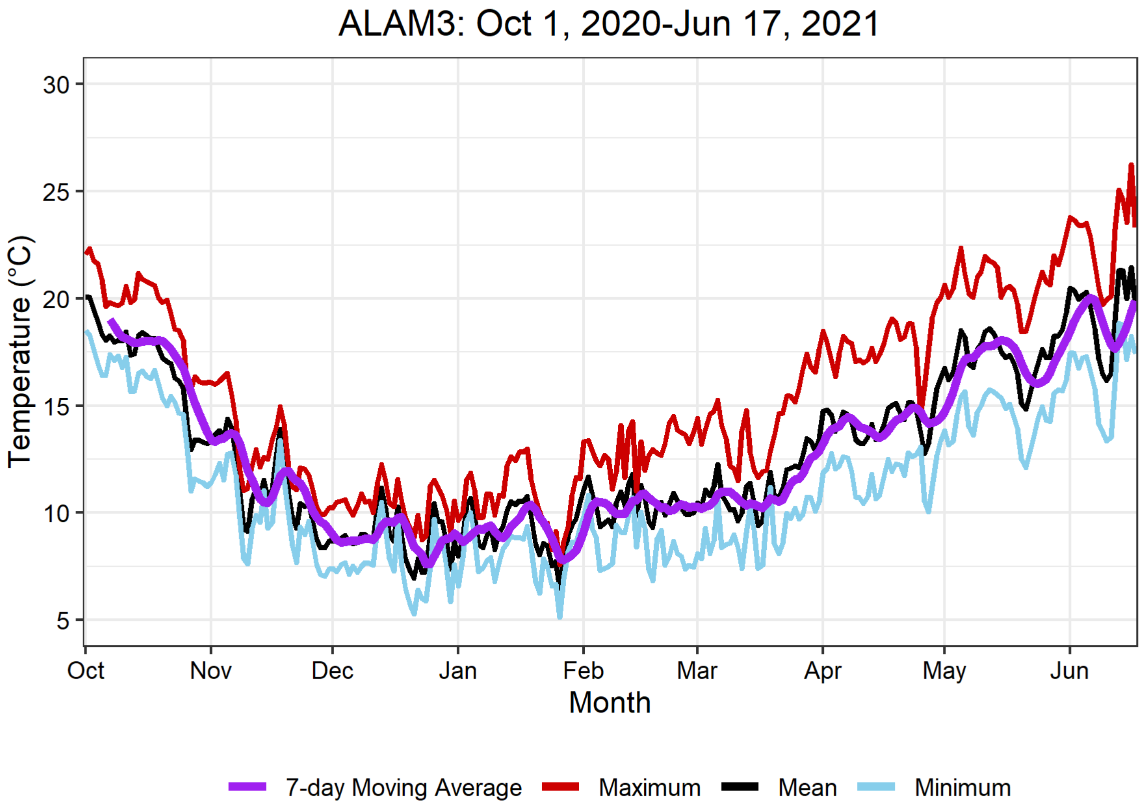

Figure 19. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM3.

ALAM4

Station ALAM4 is the most upstream monitoring station on Alamitos Creek and is located immediately downstream of the Almaden Reservoir outlet. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 20. In Water Year 2021, stream temperatures ranged from 8.2 to 25.5°C with an average daily fluctuation of 0.4°C. The MWAT for station ALAM4 during the monitoring period was 25.1°C.

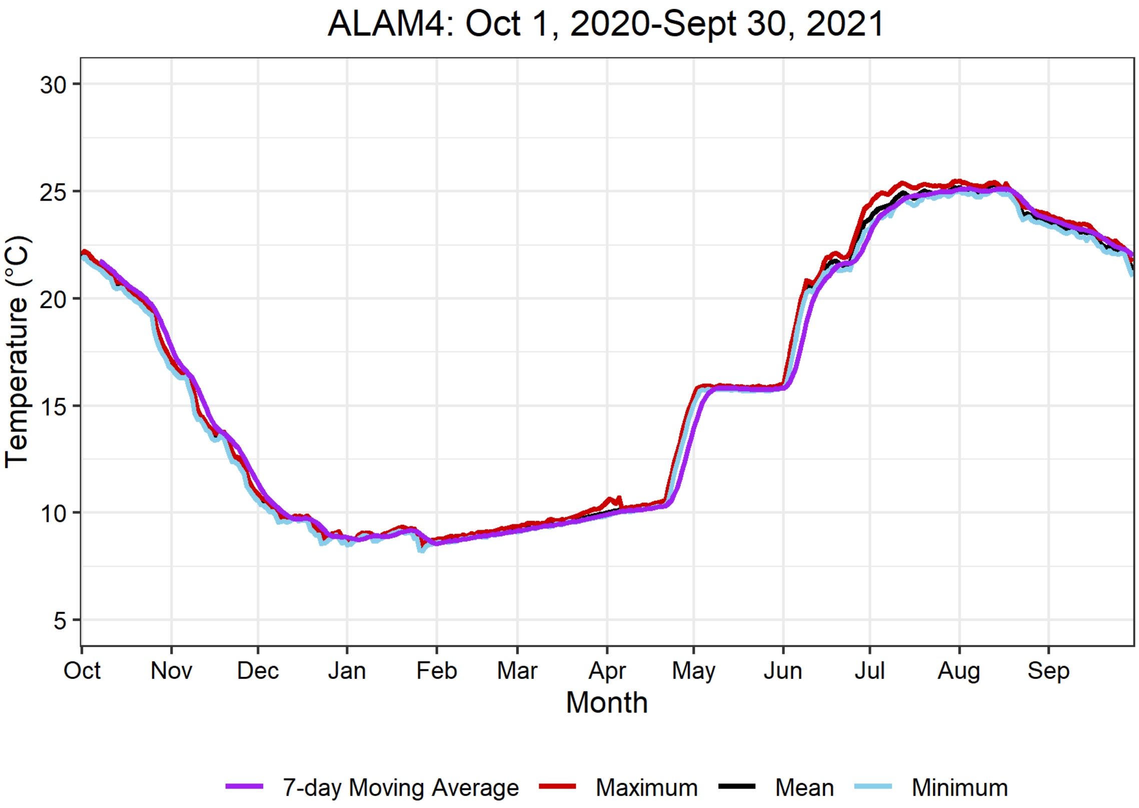

Figure 20. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station ALAM4.

Alamitos Creek Discussion

Like other creeks in the watershed, Alamitos Creek showed a similar trend where temperatures decreased from the beginning of the Water Year to the end of January, increased until mid-August, then started to decline until the end of the Water Year. However, most stations on Alamitos Creek (excluding ALAM2 and ALAM4) experienced drought-included dry back beginning in the summer and therefore only have data for a portion of the Water Year. The dip in temperature at the end of January corresponding with the large storm event was also visible on Alamitos Creek.

There were no apparent temperature patterns along the length of Alamitos Creek as overall ranges, average daily fluctuations, and MWATs were similar among stations with comparable data. However, ALAM4 (most upstream) showed much lower daily variation than the other stations. This result is to be expected due to its proximity to the outlet of Almaden Reservoir.

Almaden Reservoir is a bottom release reservoir, and as a result of the thermal buffering caused by the reservoir pool, water released is more consistent in temperature.

Across all monitoring stations (excluding ALAM4), daily ranges were greatest in the spring and summer months with large variations present between daily minimum and maximum temperatures. This trend was most pronounced at monitoring stations ALAM3 and ALAM5. These large diurnal fluctuations were also present during the previous water year (see Valley Water 2021) and therefore may be a normal pattern in this system in the warmer months. We will be able to form a more definitive conclusion as data continues to be collected over the next several years.

Los Gatos Creek

LOSG1

Station LOSG1 is the most downstream monitoring station on Los Gatos Creek and is located approximately 30 m downstream of Lincoln Avenue in San Jose. Temperature data for this logger is not available after May 20, 2021 due to drought-induced dry back. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 21. Between October 1, 2020 and May 20, 2021, stream temperatures ranged from 7.5 to 22.8°C with an average daily fluctuation of 1.8°C. The MWAT for station LOSG1 during the monitoring period was 20.4°C.

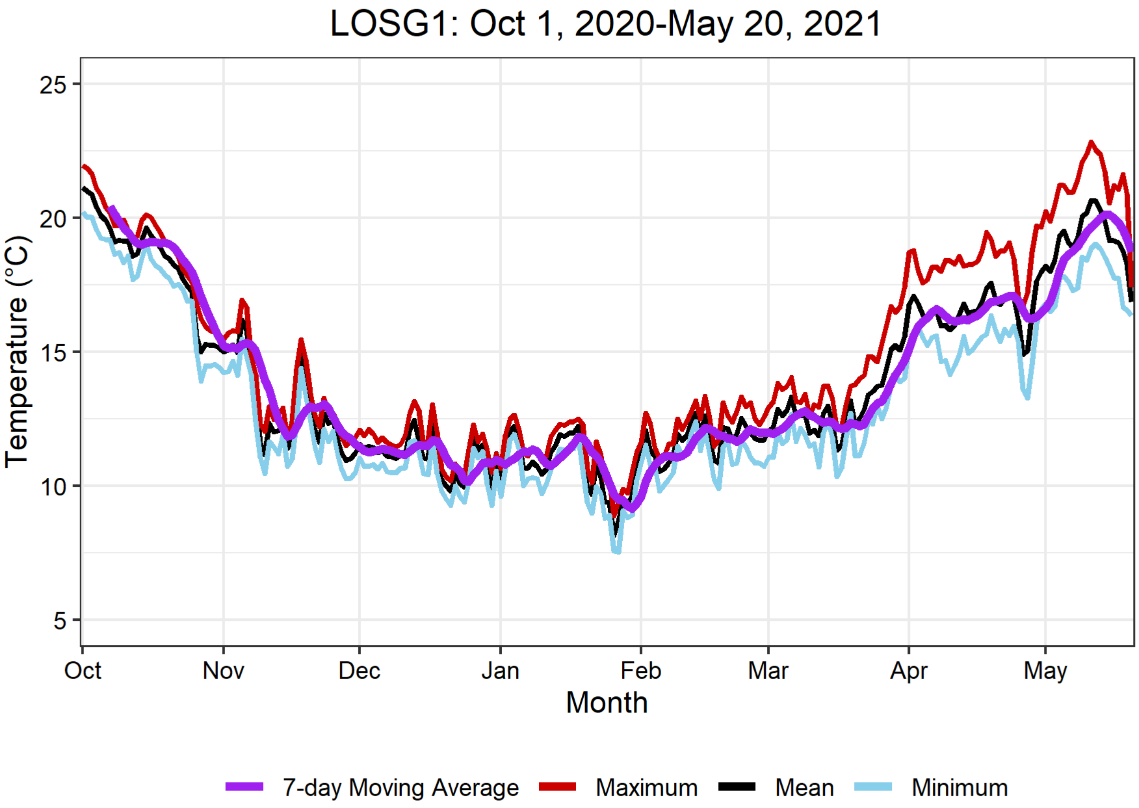

Figure 21. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station LOSG1.

LOSG3

Station LOSG3 is located upstream of LOSG1 and is approximately 45 m downstream of Highway 17 in Campbell. This station is positioned within *O. mykiss* juvenile rearing monitoring reach LG004 (see Valley Water 2022). No data is available between April 3 and 13, 2021 due to a logger malfunction. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 22. In Water Year 2021, stream temperatures ranged from 7.8 to 27.9°C with an average daily fluctuation of 2.6°C. The MWAT for station LOSG3 during the monitoring period was 23.8°C.

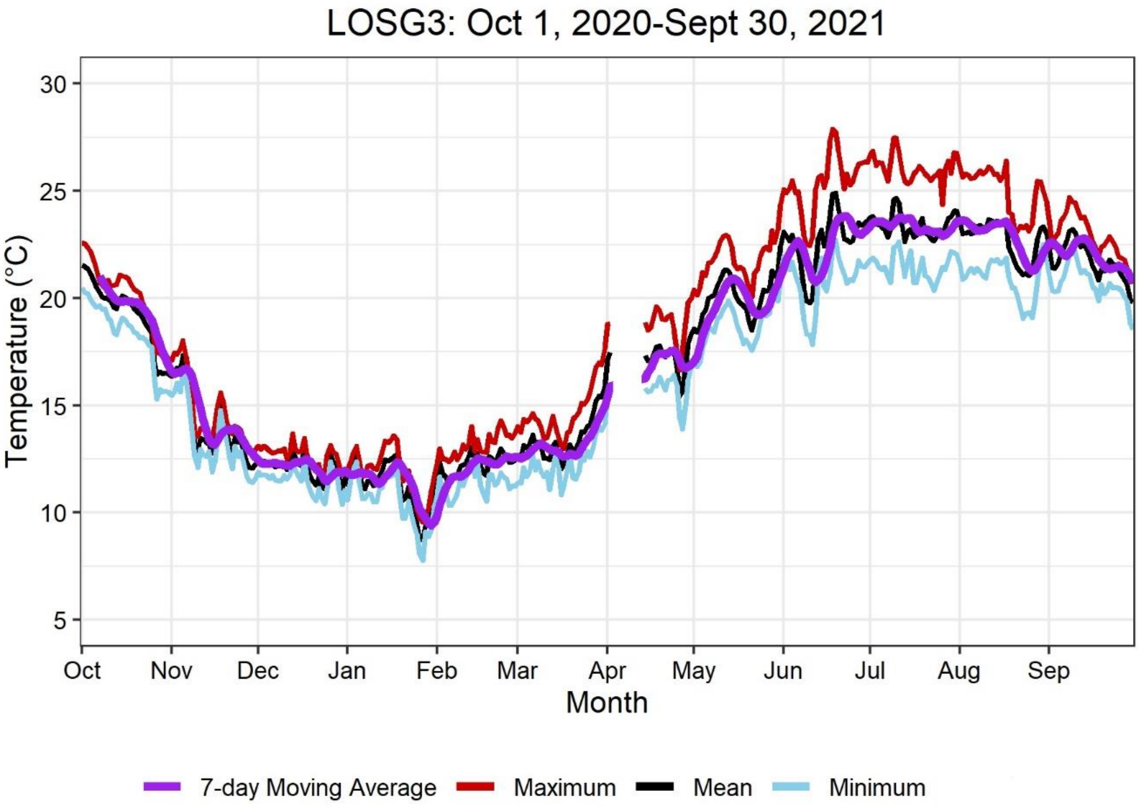

Figure 22. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station LOSG3.

LOSG2

Station LOSG2 is the most upstream monitoring station on Los Gatos Creek and was originally installed approximately 60 m downstream of the Camden Avenue Drop Structure on October 20, 2020. Temperature data for this station is intermittent (data is missing from March 3 to 27, 2021), and altogether not available after April 10, 2021 due to tampering by the public. A new logger has been deployed in a more discrete area roughly 0.6 km downstream from the original location to try to prevent future tampering. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 23. Between October 20, 2020 and April 10, 2021, stream temperatures ranged from 8.6 to 20.5°C with an average daily fluctuation of 1.1°C. The MWAT for station LOSG2 during the monitoring period was 19.1°C.

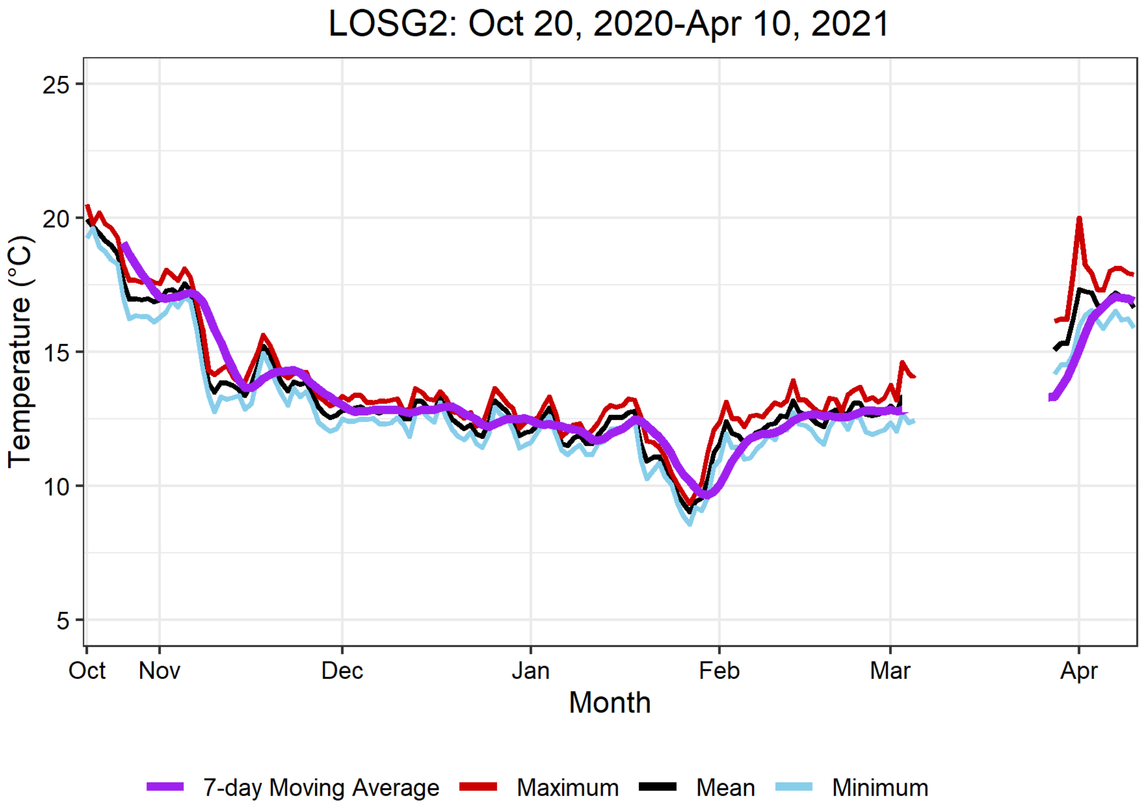

Figure 23. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station LOSG2.

Los Gatos Creek Discussion

As described in the previous systems, temperatures on Los Gatos Creek decreased from the beginning of the Water Year to the end of January, increased until mid-August, then started to decline until the end of the Water Year. The dip in temperature at the end of January was visible at all monitoring stations.

No clear temperature pattern was detected along the length of Los Gatos Creek as temperature conditions at the most downstream station (LOSG1) were similar to those at the most upstream station (LOSG2), but it should be noted that neither dataset is complete.

At monitoring stations LOSG1 and LOSG3, daily ranges were greatest in the spring and summer with large variations present between daily minimum and maximum temperatures.

These large diurnal fluctuations were also present during the previous water year (see Valley Water 2021) and therefore may be a normal pattern in this system in the warmer months. We will be able to form a more definitive conclusion as data continues to be collected over the next several years.

Calero Creek

CALE1

Station CALE1 is the most downstream monitoring station on Calero Creek and is approximately 215 m upstream of the Alamitos Creek confluence. This station is roughly 60 m downstream of *O. mykiss* juvenile rearing monitoring site CC001 (see Valley Water 2022). Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 24. In Water Year 2020, stream temperatures ranged from 8.3 to 22.6°C with an average daily fluctuation of 2.7°C. The MWAT for station CALE1 during the monitoring period was 20.1°C.

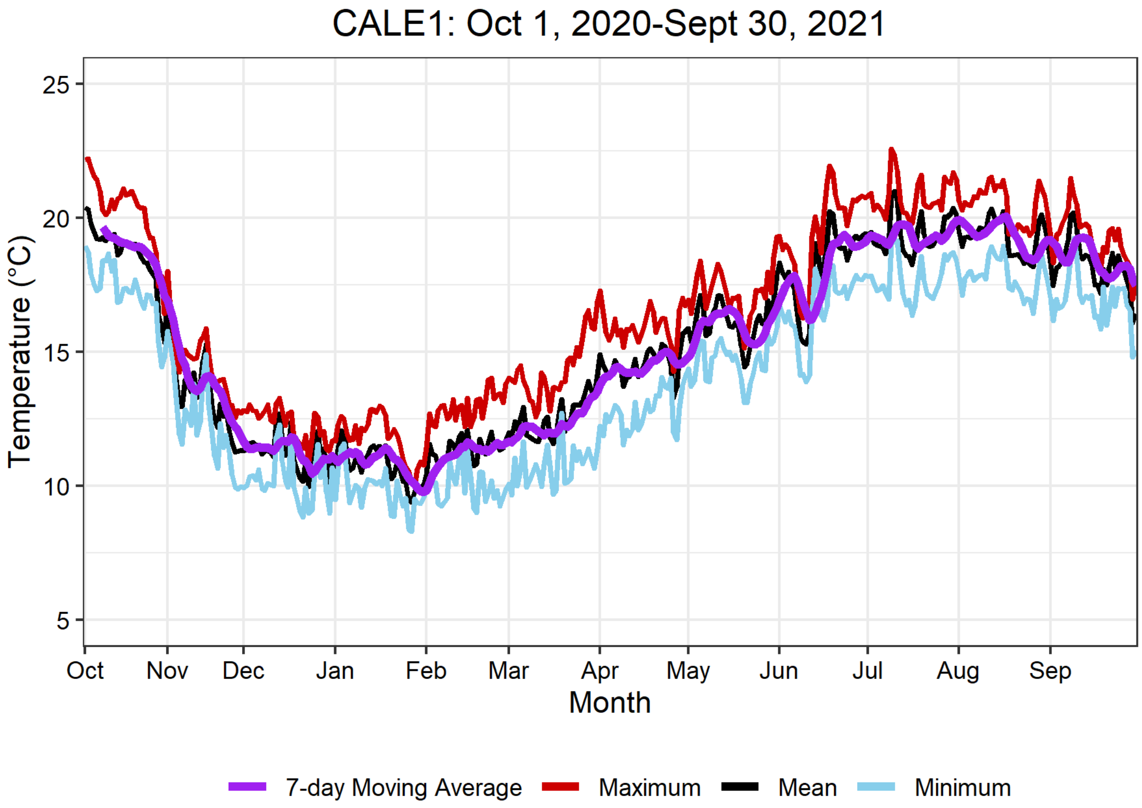

Figure 24. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station CALE1.

CALE3

Station CALE3 is located upstream of CALE1 and is approximately 0.8 km upstream of Harry Road in South San Jose. This station is positioned within *O. mykiss* juvenile rearing monitoring reach CC003 (see Valley Water 2022). Temperature data for this logger is not available after August 10, 2021 due to drought-induced dry back. It is of note that because of low flows beginning in April, the logger was observed to be in very shallow water for the last few months of deployment and out of the water for part of the month of June. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 25. Between October 1, 2020 and August 10, 2021, stream temperatures ranged from 8.3 to 22.7°C with an average daily fluctuation of 4.0°C. The MWAT for station CALE3 during the monitoring period was 20.1°C.

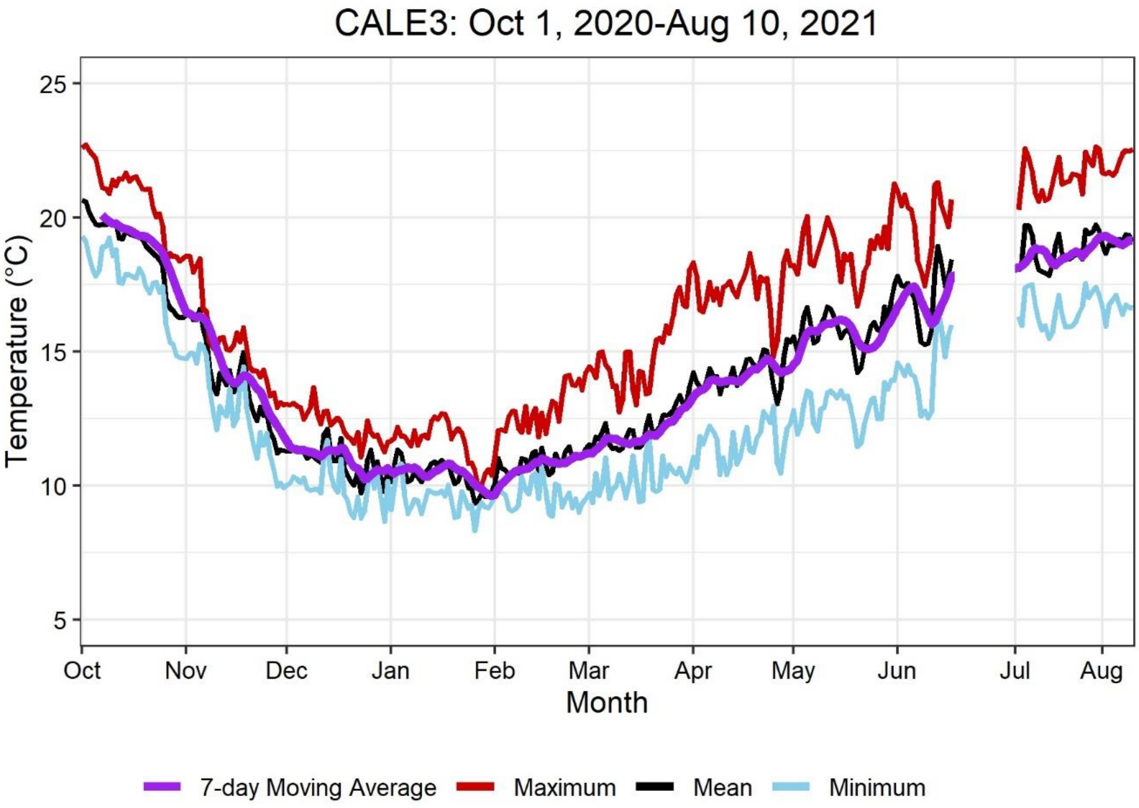

Figure 25. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station CALE3.

CALE2

Station CALE2 is the most upstream monitoring station on Calero Creek and is approximately 150 m downstream of Calero Reservoir. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 26. In Water Year 2021, stream temperatures ranged from 9.3 to 21.6°C with an average daily fluctuation of 0.6°C. The MWAT for station CALE2 during the monitoring period was 21.4°C.

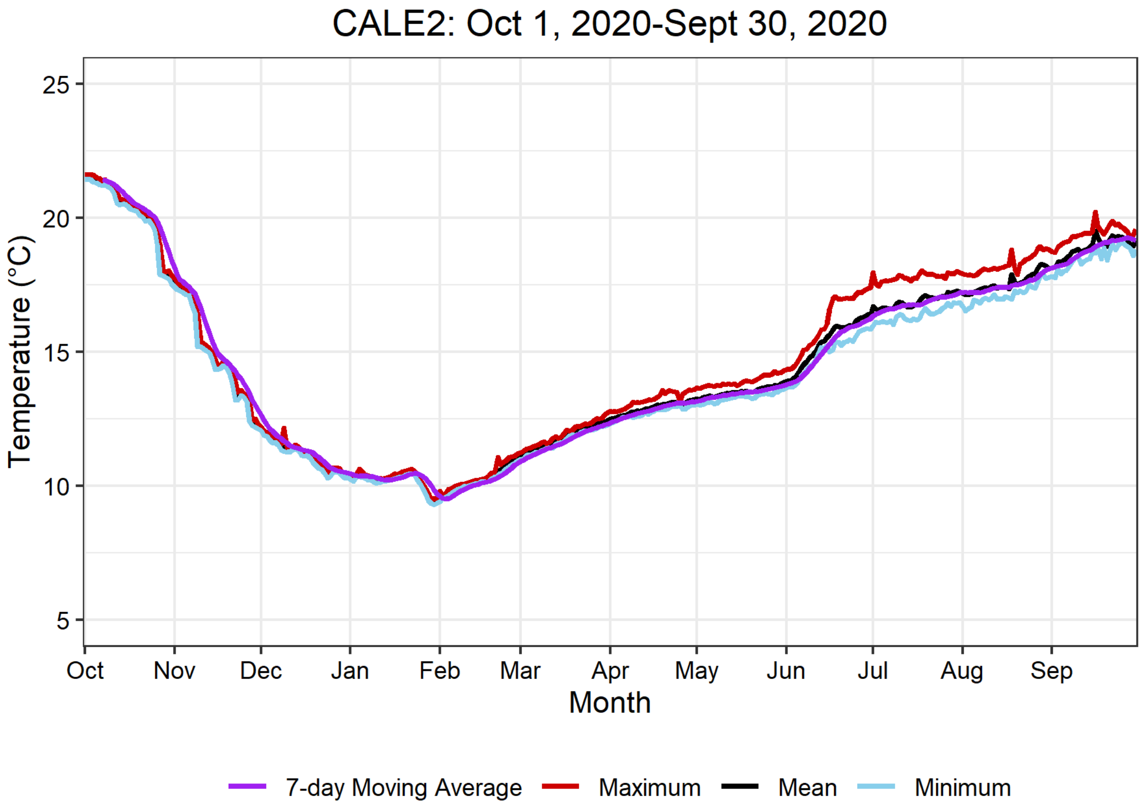

Figure 26. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station CALE2.

Calero Creek Discussion

CALE1 displayed the same trend as other systems, where temperatures decreased from the beginning of the Water Year to the end of January, increased until mid-August, then started to decline until the end of the Water Year. CALE3 also showed this trend until data was no longer available after August 10, 2021. However, unlike the other stations, summer temperatures at CALE2 did not appear to start declining until the end of September.

There were no apparent temperature patterns along the length of Calero Creek as overall ranges and MWATs were similar among stations. However, CALE3 had a significantly high average daily fluctuation, likely due to the shallow conditions at this station. In contrast, CALE2 (most upstream) showed much lower daily variation than the other two stations. This result is to be expected due to its proximity to the outlet of Calero Reservoir. Calero Reservoir is a bottom release reservoir, and as a result of the thermal buffering caused by the reservoir pool, releases water that is more consistent in temperature.

Similar to other systems in the watershed, daily ranges were greatest during the warmer months of the year. These large diurnal fluctuations were also present during the previous water year (see Valley Water 2021) and therefore may be a normal pattern in this system in the spring and summer months. We will be able to form a more definitive conclusion as data continues to be collected over the next several years.

Conclusion

Within the Guadalupe River Watershed in Water Year 2021, Guadalupe Creek, Alamitos Creek, and Calero Creek supported multiple *O. mykiss* age classes and summer rearing occurred in low densities based on the results of Valley Water's juvenile rearing monitoring effort (Valley Water 2022). Across the 18 juvenile rearing sites sampled in these creeks, a total of 37 *O. mykiss* were collected. All individuals were in healthy condition based on the results of a fish condition analysis (Valley Water 2022). The Guadalupe River Watershed supported rearing and persistence of juvenile *O. mykiss,* including in years with low flow conditions such as this one. Continuing to monitor stream temperatures, in conjunction with juvenile rearing sampling and other fisheries monitoring efforts, will be useful towards furthering our understanding of *O. mykiss* in the Guadalupe River Watershed.

As stream temperature monitoring continues over time and improvements to data collection methods are made, this information will provide valuable insights into evaluating long-term temperature trends, assessing the effectiveness of potential restoration projects, and informing *O. mykiss* management objectives.

References

Valley Water. 2021. 2019-2020 Guadalupe River Watershed Stream Temperature Monitoring.

Valley Water. 2022. 2021 Juvenile *O. mykiss* Rearing Monitoring in the Guadalupe River Watershed.

Appendix B

2021 Guadalupe River Watershed Central California Coast Steelhead (*Oncorhynchus mykiss*) Fish Condition Analysis

2021 Guadalupe River Watershed Central California Coast Steelhead (*Oncorhynchus mykiss)* Fish Condition Analysis

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January 2022

Contents

Background 1
Introduction 1
Methods 3
  Data Collection 3
  Calculations 3
  Relative Weight Target Range 5
  Interannual Comparisons 5
Results 6
Discussion 13
References 18

Tables

Table 1. Summary statistics of measured weights and fork-lengths for juvenile O. mykiss sampled in the Guadalupe River Watershed. 6
Table 2. Summary statistics of juvenile O. mykiss W_r for Alamitos, Calero, and Guadalupe Creeks. 6
Table 3. Summary statistics of Guadalupe River Watershed juvenile O. mykiss relative weights (W_r) per 25-mm length class. 9
Table 4. Summary statistics of juvenile O. mykiss population W_r for Alamitos, Calero, and Guadalupe Creeks from 2018 to 2021. 12

Figures

Figure 1. Boxplots of relative weights (W_r) for juvenile *O. mykiss* sampled in Alamitos Creek (n = 3), Calero Creek (n = 28), and Guadalupe Creek (n = 6) within the Guadalupe River Watershed. 7
Figure 2. Relative weight (W_r) as a function of fork-length for juvenile *O. mykiss* sampled in Alamitos Creek (R^2 = 0.979), Calero Creek (R^2 = 0.009), and Guadalupe Creek (R^2 = 0.145) within the Guadalupe River Watershed. 8
Figure 3. Boxplots of juvenile *O. mykiss* relative weights (W_r) per 25-mm length class for A) Alamitos Creek, B) Calero Creek, and C) Guadalupe Creek. 10
Figure 4. Boxplot of juvenile *O. mykiss* relative weight (W_r) by black spot severity across all creeks in the Guadalupe River Watershed. 11
Figure 5. Boxplots of relative weights (W_r) for juvenile O. mykiss sampled in Alamitos Creek, Calero Creek, and Guadalupe Creek within the Guadalupe River Watershed from 2018 to 2021 13

Appendices

Appendix A: Individual Measurements, Standard Weights (W_s), Relative Weights (W_r), and Black Spot Severity of *O. mykiss* Sampled During Fall 2021 Guadalupe River Watershed Juvenile Rearing Monitoring

Introduction

The 440 km^2 Guadalupe River Watershed begins in headwater tributaries near the summits of Loma Prieta and Mount Umunhum in the Santa Cruz Mountains, then flows north into the mainstem Guadalupe River before draining into South San Francisco Bay through Alviso Slough. The upper watershed areas are less developed than the lower reaches and experience a lower degree of anthropogenic disturbance. The northern portions of the watershed are comprised of the Santa Clara County valley floor through the City of San Jose, California. The majority of the valley floor is extensively urbanized with patches of undeveloped parks and open agricultural lands. Major tributaries in the Guadalupe River Watershed include Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek.

The Guadalupe River Watershed supports the federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS) in five of its systems: Guadalupe River, Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek. The portion of the Guadalupe River between its confluence with San Francisco Bay and West Hedding Street in San Jose is designated as critical habitat for the species (70 FR 52570, September 2005). To better understand the health of juvenile *O. mykiss* in the Guadalupe River Watershed, fish condition was analyzed for *O. mykiss* sampled during Valley Water’s 2021 juvenile rearing monitoring season. The relative weight approach was used to evaluate fish condition due to its utility, the ease with which it can be calculated and analyzed, and its ability to be compared among populations.

Background

Fish condition can be determined based on a measure of length and weight that represents the physiological or nutritional state of a fish. This analysis can be used to assess the effects of biotic and abiotic factors on the health of a population (Murphy et al. 1990, Cone 1989). Therefore, monitoring fish condition can be useful for informing management recommendations concerning fish populations.

Relationships between weight and length are often used for assessing population size structure and individual fish condition. Because fish weight is directly related to fish length, weight-length data is not only used to predict one from the other, but it can also be used as an indicator of an individual's fatness (or condition) by measuring the variation from the expected weight for a certain length (LeCren 1951). The traditional approach to assessing fish condition involves the use of a 'condition factor,' which employs a fixed ratio to describe the relationship between fish length and weight (Murphy et al. 1991). The commonly used Fulton's condition factor (K) (Fulton 1904) is calculated as:

$$K = W / L^3$$

Where W is weight and L is length. Though it has the advantage of being easy to calculate, Fulton's condition factor has its drawbacks. First, it assumes isometric growth (power = 3, fish shape does not change with growth), which is rarely the case for most fish species (Froese 2006). Second, it is highly length- and species-dependent; therefore, it can only be reliably used to compare individuals with similar lengths and is practically impossible to compare across species. LeCren (1951) developed the relative condition factor (K_n) to address these issues, which is calculated with the formula:

$$K_n = W / W' \times 100$$

Where W is the actual weight of the individual fish and W' is the predicted length-specific mean weight for the population under study. While this approach solved the problem of comparing fish of different lengths and species, it is population-dependent and thus cannot be used to compare fish condition across populations.

The concept of 'relative weight' as a condition index was first introduced by Wege and Anderson (1978) for measuring the condition of largemouth bass (*Micropterus salmoides*). The relative weight approach compares fish weight to a benchmark, or standard weight, of that species based on weight-length data collected throughout its range. Wege and Anderson believed that relative weight had several advantages over other condition factors: 1) it is easy to calculate, 2) relative weight does not change with different units of measure, 3) standard weights compensate for inherent changes in body form, and 4) relative weight values can be compared between fish of different lengths and from different populations (Blackwell et al. 2000). For these reasons, the relative weight index has become widely used in recent years as a measure of fish condition.

Methods

Data Collection

In fall 2021, length-weight data was collected from juvenile *O. mykiss* sampled during Valley Water's Guadalupe River Watershed index reach monitoring effort. The purpose of this annual monitoring effort is to document the abundance, distribution, and densities of *O. mykiss* in salmonid streams within the Guadalupe River Watershed. Sampling occurred in Guadalupe River and Alamitos, Calero, Guadalupe, and Los Gatos Creeks. *O. mykiss* were present in Alamitos Creek, Calero Creek, and Guadalupe Creek during fall 2021 sampling. For details on data collection methods, including sampling sites and fish processing procedures, please refer to the 2021 Juvenile *O. mykiss* Rearing Monitoring in the Guadalupe River Watershed report (Valley Water 2022).

Calculations

The standard weight for each fish was calculated from their measured length using the following standard weight equation developed for juvenile *O. mykiss* ranging from 50 to 200 mm fork-length (Duffy 2006):

$$\log_{10}W_s = -4.790 + 2.928\log_{10}FL$$

Where W_s is the standard weight in grams and FL is the fork-length in millimeters. This standard weight equation was developed using weight-length data from 121 *O. mykiss* populations ranging from southern Alaska through central California (Duffy 2006), including populations within the CCC DPS. The equation was formed using the regression-line-percentile technique (Murphy et al. 1990), which is based on 75th-percentile weights and uses $\log_{10}$ transformed data from a series of populations as the statistical population to be modeled (Blackwell et al. 2000).

The slope of the standard weight equation ($b = 2.928$) developed by Duffy (2006) indicates that juvenile *O. mykiss* ranging from Alaska through central California exhibit slight negative allometric growth (they become more elongated as they grow, $b < 3$)).

Standard weight was then used to calculate relative weight of individuals with the equation:

$$W_r = (W / W_s) \times 100$$

Where W_r is the relative weight and W is the weight of the fish being compared in grams. The factor 100 is used to express the equation as a percentage of W_s. Note that once $\log_{10}W_s$ was determined for each fish using the standard weight equation, the antilog of these values was used in the above equation to calculate W_r.

Individuals were then categorized into 25-mm fork-length classes (hereafter referred to as length classes) in order to analyze for any length-related condition trends in the populations sampled (Blackwell 2000).

Because some *O. mykiss* sampled in the watershed were infected with black spot disease[1], the relationship between black spot severity and W_r was assessed for the watershed as a whole to evaluate whether there was a negative correlation between black spot disease and fish condition.

The Kruskal-Wallis test was used to determine if there were statistically significant differences in W_r between creeks, between length classes for each creek, and between black spot severities ($p < 0.05$). Considered the nonparametric alternative to the one-way ANOVA, the Kruskal-Wallis test was used for this study due to the non-normal data distributions and small sample sizes. A significant Kruskal-Wallis test was followed by a post hoc Dunn's test to identify which groups were significantly different.

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[1] Black spot disease is the common name for a parasitic infection of the developing stage, or metacercaria, of *Digenea* flatworms that produce a melanin-induced fibrous cyst (Schaaf et al. 2017). While effects of black spot disease on fish are not well understood, they are generally not believed to be harmful.

Relative Weight Target Range

The regression-line-percentile technique used to develop the standard weight equation above uses 75th-percentile weights; therefore, a W_r value of 100 (the actual weight of the fish equals the standard weight) is not an average-sized fish. Rather, it means that across their range, 25% of the juvenile *O. mykiss* will have a W_r value greater than 100 while 75% will be less than 100. A fish with a W_r of 100 is thus considered to be in better-than-average condition. For the original development of the W_r index (Wege and Anderson 1978), 75th-percentile weights were also used as a standard. Anderson (1980) subsequently recommended that 95−105 be used as a W_r target range in order to aim for fish populations that are in above average condition, and it has since been widely used by fisheries managers.

Nonetheless, Murphy et al. (1991) cautioned against using a universal target range for optimal condition, believing that “optimal” will vary according to specific management objectives and environmental limitations. Targets for W_r should therefore be established according to the management goals for a given program, but further research is needed to evaluate appropriate W_r target ranges for juvenile *O. mykiss* populations under various management scenarios.

For the purposes of this report, the W_r target range of 95−105 (Anderson 1980) was used to define fish in optimal condition. This W_r target range may be modified in the future as more data is collected and as management objectives for the Guadalupe River Watershed become established.

Interannual Comparisons

During sampling in the Guadalupe River Watershed from 2018−2020, juvenile *O. mykiss* were also present in Alamitos, Calero, and Guadalupe Creeks (SCVWD 2019; Valley Water 2020, Valley Water 2021). The population W_r of juvenile *O. mykiss* in these creeks was compared between 2021 and previous sampling years to evaluate for any fish condition changes over time. The Kruskal-Wallis test was used to look for significance between years; a significant Kruskal-Wallis test was followed by a post hoc Dunn’s test to identify which years were significantly different.

Results

In total, 37 *O. mykiss* were sampled during the 2021 Guadalupe River Watershed juvenile rearing monitoring season (Alamitos Creek, n = 3; Calero Creek, n = 28; Guadalupe Creek, n = 6). Summary statistics for measured weights and fork-lengths of fish sampled in each creek are provided in Table 1.

Table 1. Summary statistics of measured weights and fork-lengths for juvenile *O. mykiss* sampled in the Guadalupe River Watershed. Means are presented as the value ± SD. Sample size = n.

Creek	**n**	**Mean Weight (g)**	**Weight Range (g)**	**Mean Fork-Length (mm)**	**Fork-Length Range (mm)**
Alamitos	3	6.1 ± 1.8	5.0−8.2	78 ± 5.2	75−84
Calero	28	8.4 ± 14.5	2.5−81.5	76.9 ± 22.7	57−182
Guadalupe	6	19.0 ± 16.5	5.8 – 52.8	109.5 ± 36.8	78 − 171
Total	37	9.9 ± 14.8	2.5–81.5	82.2 ± 26.9	57−182

Mean W_r was highest in Calero Creek at 116.5 (SD=12.5), followed by Alamitos Creek at 106.3 (SD=9.7) and Guadalupe Creek at 101.5 (SD=10.1). Population W_r differed significantly between Calero Creek and Guadalupe Creek (Dunn's test; $p = 0.023$). Summary statistics of W_r per creek are provided in Table 2 and distributions are shown in Figure 1.

Table 2. Summary statistics of juvenile *O. mykiss* W_r for Alamitos, Calero, and Guadalupe Creeks. Means are presented as the value ± SD. Sample size = n.

Creek	**n**	**Mean W_r (%)**	**W_r Range (%)**
Alamitos	3	106.3 ± 9.7	99.7−117.4
Calero	28	116.5^{a} ± 12.5	91.3−143.1
Guadalupe	6	101.5^{b} ± 10.1	94.3–121.0
Different letters indicate statistically significant differences between creeks (Kruskal-Wallis test followed by Dunn's test, $p < 0.05$)			

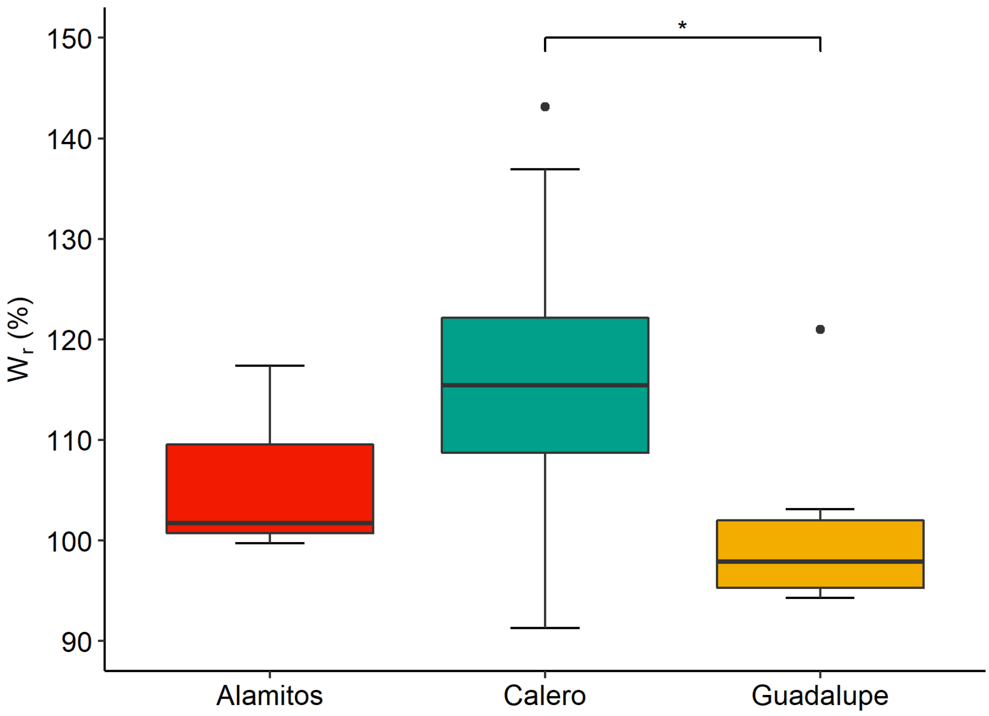

Figure 1. Boxplots (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges, and outlying points beyond whiskers) of relative weights (W_r) for juvenile *O. mykiss* sampled in Alamitos Creek (n = 3), Calero Creek (n = 28), and Guadalupe Creek (n = 6) within the Guadalupe River Watershed. *Significance at the 0.05 probability level.

Relative weight plotted as a function of fork-length (Figure 2) revealed a slight negative length-related trend for Guadalupe Creek, but fork-length did not have a significant effect on W_r based on a linear regression analysis (adjusted R^2 = 0.145, 95% CI [-0.47, 0.16], p = 0.246). For Alamitos Creek and Calero Creek, W_r versus fork-length showed a positive trend visually and there was a high correlation for Alamitos Creek; however, neither creek had a statistically significant relationship between W_r and fork-length (Alamitos: adjusted R^2 = 0.979, 95% CI [-0.59, 4.29], p = 0.066; Calero: adjusted R^2 = 0.009, 95% CI [-0.09, 0.34], p = 0.270).

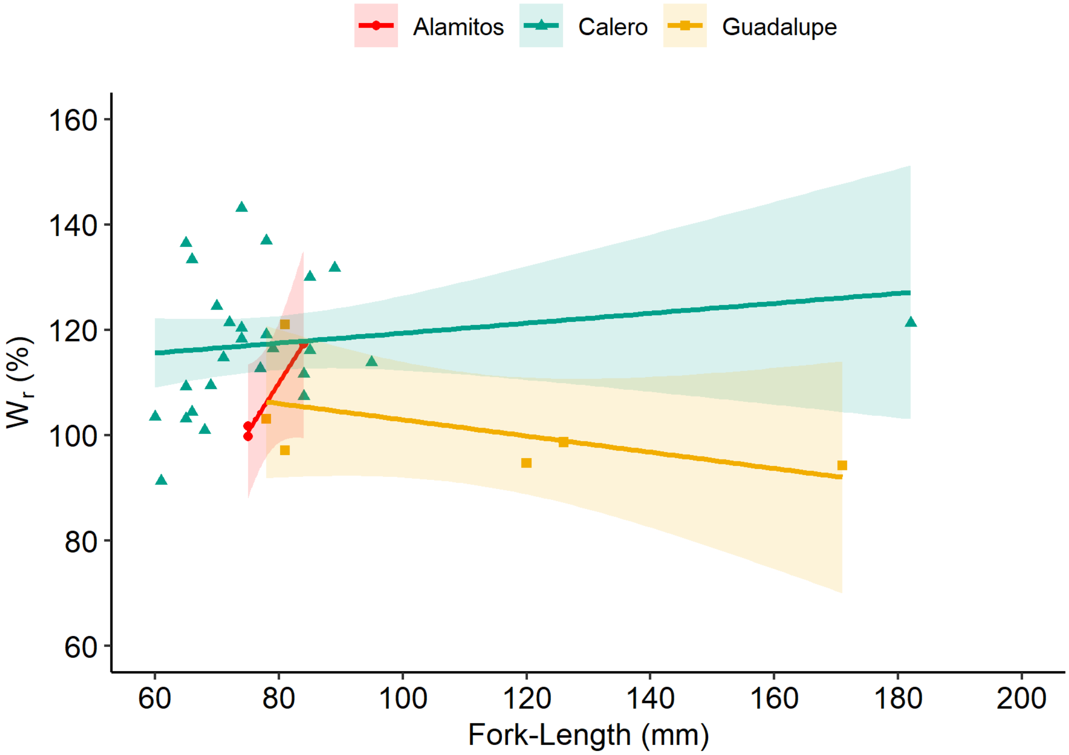

Figure 2. Relative weight (W_r) as a function of fork-length for juvenile *O. mykiss* sampled in Alamitos Creek (R^2 = 0.979), Calero Creek (R^2 = 0.009), and Guadalupe Creek (R^2 = 0.145) within the Guadalupe River Watershed. Points, regression lines, and confidence bands are colored by creek.

Summary statistics for W_r per 25-mm length class are provided in Table 3 and distributions are shown in Figure 3. For all three creeks, there were no statistically significant differences in mean W_r among length classes as determined by a Kruskal-Wallis test (Alamitos: H = 1.5, df = 1, p = 0.221; Calero: H = 1.71, df = 2, p = 0.425; Guadalupe: H = 3.67, df = 3, p = 0.300).

Table 3. Summary statistics of Guadalupe River Watershed juvenile *O. mykiss* relative weights (W_r) per 25-mm length class. Means are presented as the value ± SD. Sample size = n.

Length Class (mm)	**n**	**Mean W_r (%)**	**W_r Range (%)**
Alamitos Creek			
51-75	2	100.72 ± 1.41	99.72−101.72
76-100	1	117.36	117.36
Calero Creek			
51-75	17	114.48 ± 14.10	91.30−143.13
76-100	10	119.57 ± 9.84	107.34−136.91
176-200	1	121.25	121.25
Guadalupe Creek			
76-100	3	107.08 ± 12.42	97.11−120.99
101-125	1	94.69	94.69
126-150	1	98.68	98.68
151-175	1	94.28	94.28

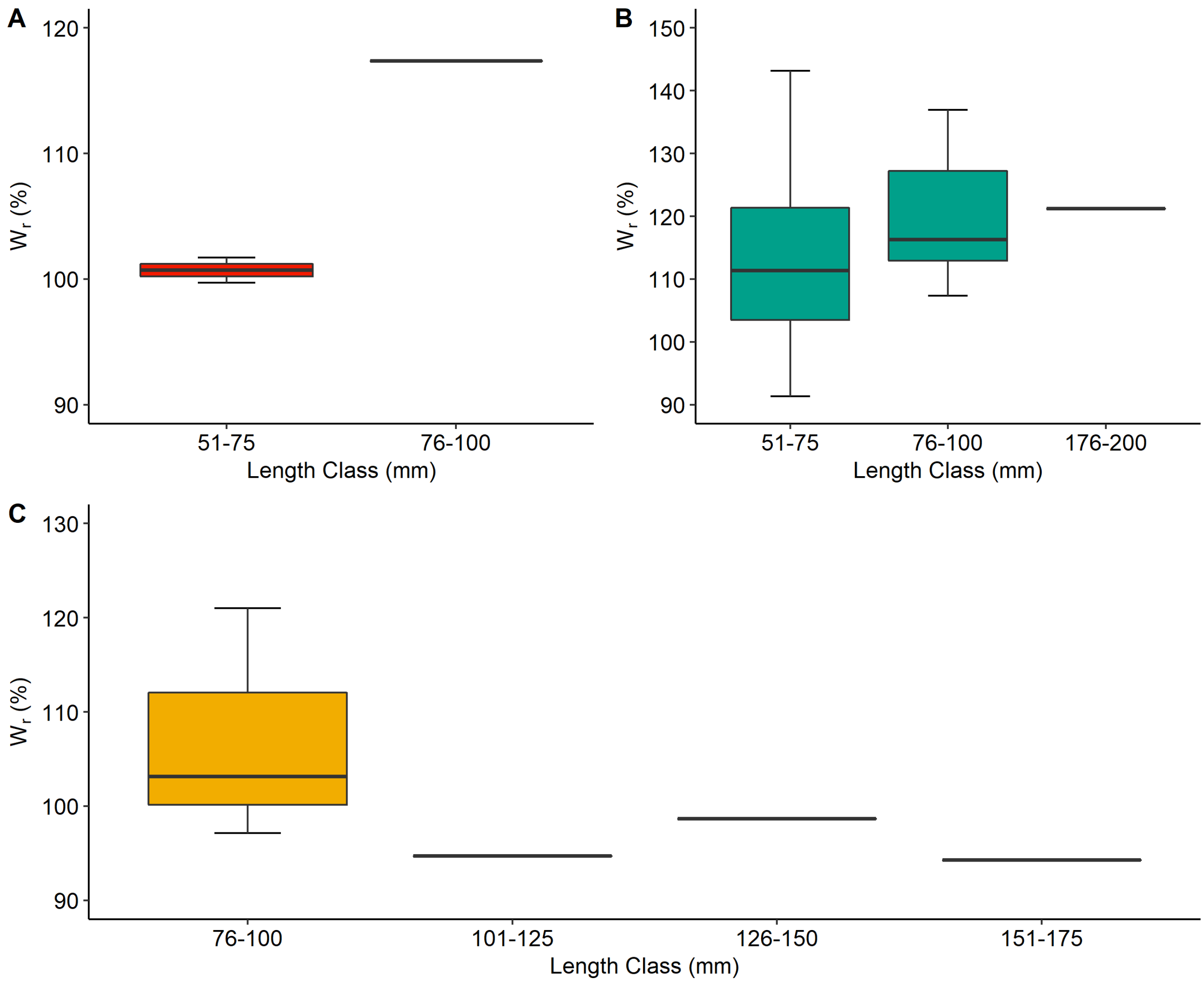

Figure 3. Boxplots (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges) of juvenile *O. mykiss* relative weights (W_r) per 25-mm length class for A) Alamitos Creek, B) Calero Creek, and C) Guadalupe Creek.

Of the 37 *O. mykiss* sampled in the Guadalupe River Watershed in 2021, six fish were infected with black spot (16%). Black spot severity was ranked on a scale of 0−3 where 0 = no infection, 1 = low infection (cysts cover <10% of the body), 2 = moderate infection (cysts cover 10-25% of the body), and 3 = severe infection (cysts cover >25% of the body) (Valley Water 2022). Black spot infection was observed in fish sampled from Alamitos Creek and Calero Creek with three infected fish from each creek. Four infected fish were ranked as 1 and two were ranked as 2. Black spot severity appeared to have no effect on W_r as there were no statistically significant differences in mean W_r

among severity ranks 0 through 2 (Kruskal-Wallis test; $H = 0.13$, $df = 2$, $p = 0.939$) (Figure 4).

Individual fish measurements, W_s, W_r, and black spot severity are provided in Appendix A.

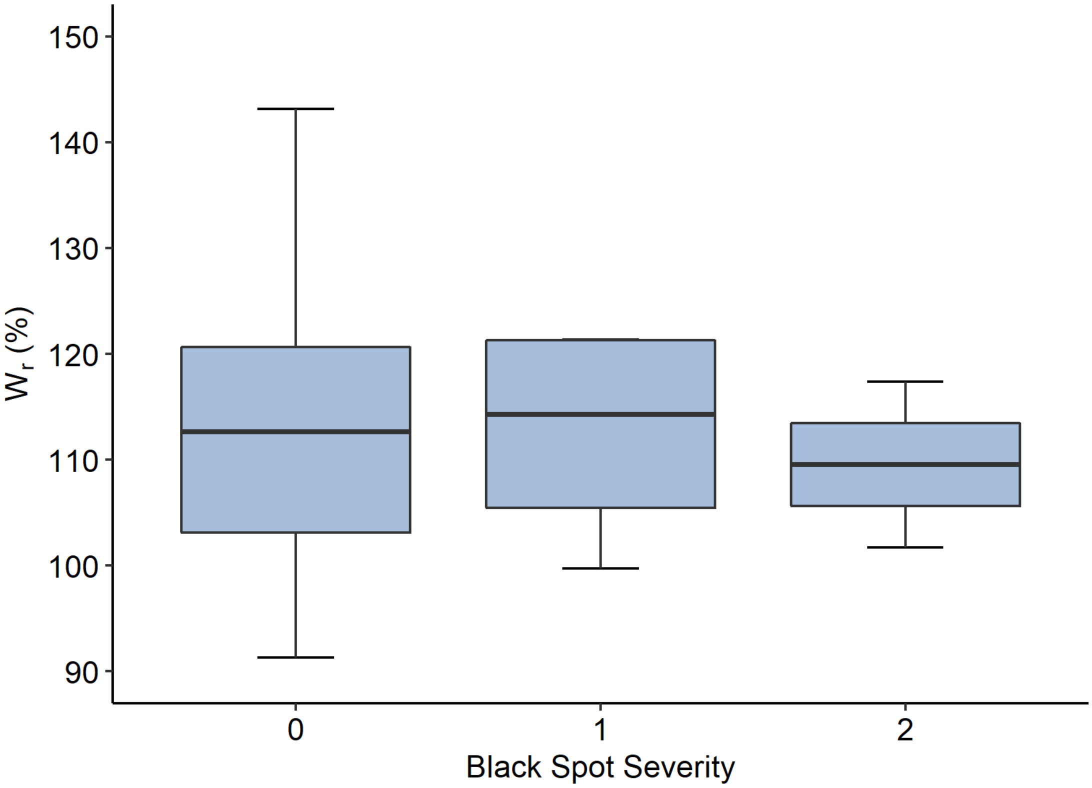

Figure 4. Boxplot (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges) of juvenile *O. mykiss* relative weight (W_r) by black spot severity across all creeks in the Guadalupe River Watershed. Black spot severity scale is defined as: 0 = no infection, 1 = low infection, and 2 = moderate infection (Valley Water 2022).

Since sampling was first conducted in all creeks in 2018, Calero Creek and Guadalupe Creek both had their highest mean W_r in 2018, whereas Alamitos Creek showed its highest mean W_r in 2019. Mean W_r was lowest in Alamitos Creek in 2021, and in Guadalupe and Calero Creeks in 2020. There were no significant differences in juvenile *O. mykiss* W_r between any years when sampling occurred in Alamitos Creek (Kruskal-

Wallis test; H = 5.65, df = 3, p = 0.129). However, W_r of *O. mykiss* sampled in Calero Creek differed significantly between 2018 and 2020 (Dunn's test; p = 0.002) and 2020 and 2021 (Dunn's test; p = 0.007). Guadalupe Creek showed significant differences in W_r between 2018 and 2020 (Dunn's test; p < 0.001), 2018 and 2021 (Dunn's test; p = 0.009), 2019 and 2020 (Dunn's test; p = 0.004), and 2020 and 2021(Dunn's test; p = 0.044). Summary statistics for W_r by creek and year are provided in Table 4 and distributions are shown in Figure 5.

Table 4. Summary statistics of juvenile *O. mykiss* population W_r for Alamitos, Calero, and Guadalupe Creeks from 2018 to 2021. Means are presented as the value ± SD. Sample size = n.

Year	**n**	**Mean W_r (%)**	**W_r Range (%)**
Alamitos Creek			
2018	59	113.7 ± 13.5	92.1 – 166.2
2019	48	114.1 ± 9.4	99.4 – 148.5
2020	21	107.7 ± 17.8	83.5−150.3
2021	3	106.3 ± 9.7	99.7−117.4
Calero Creek			
2018	15	120.2 ± 13.0^a	95.4 – 144.3
2019	7	111.0 ± 8.1	102.9 – 122.8
2020	34	107.2 ± 11.8^b	84.1−153.3
2021	28	116.5 ± 12.5^a	91.3−143.1
Guadalupe Creek			
2018	66	119.4 ± 14.1^a	86.5 – 152.3
2019	33	115.7 ± 11.6^a	94.5 – 153.5
2020	13	100.0 ± 11.1^b	82.2–120.1
2021	6	101.5 ± 10.1^b	94.3–121.0

Different letters indicate statistically significant differences between years (Kruskal-Wallis test followed by Dunn's test, p < 0.05).

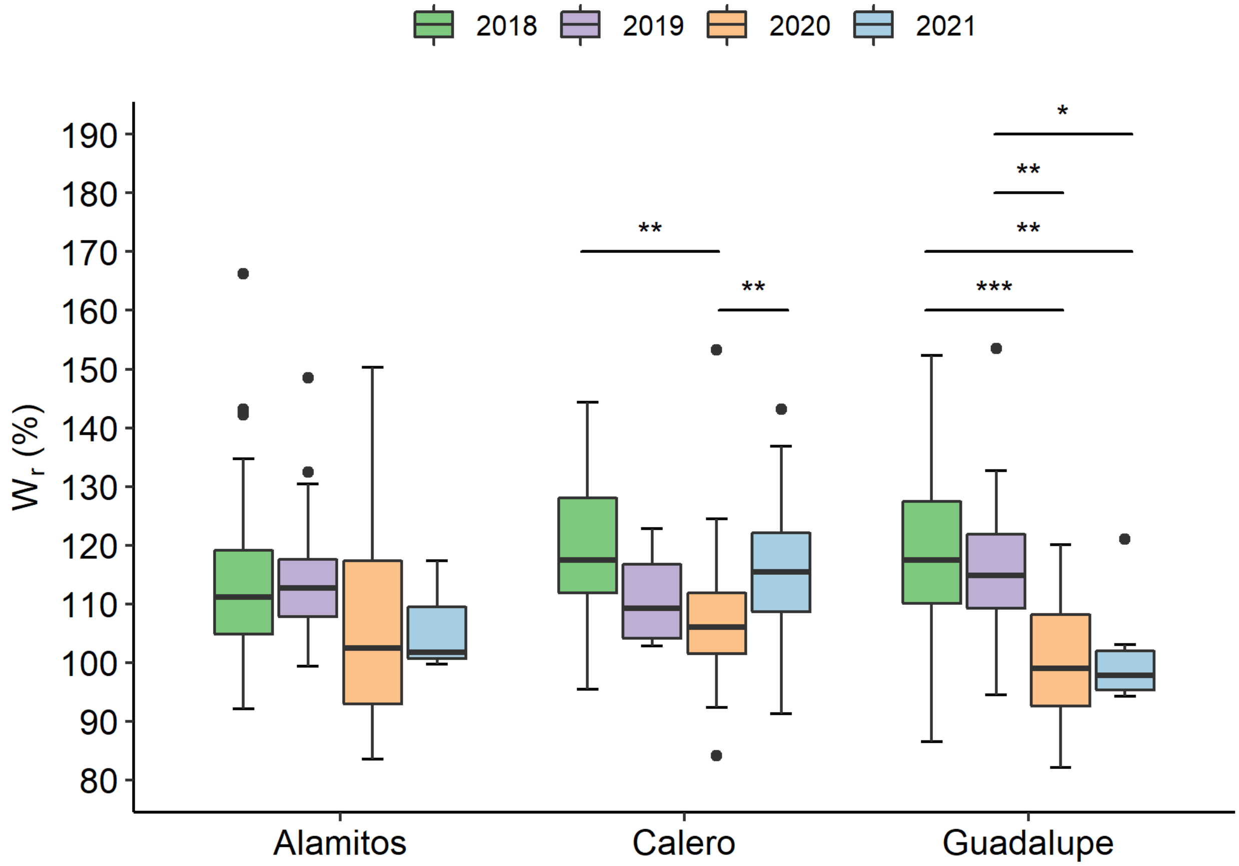

Figure 5. Boxplots (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges, and outlying points beyond whiskers) of relative weights (W_r) for juvenile *O. mykiss* sampled in Alamitos Creek, Calero Creek, and Guadalupe Creek within the Guadalupe River Watershed from 2018 to 2021. *Significance at the 0.05 probability level. **Significance at the 0.01 probability level. ***Significance at the 0.001 probability level.

Discussion

Though visual trends were present, the relationship between length and W_r was not significant in any of the creeks, suggesting that the condition of juvenile *O. mykiss* in these systems did not differ substantially between fish of varying lengths/ages. However, the large discrepancies in sample size among length classes should be noted when interpreting these results. Because only one fish was sampled in several of the length classes, conclusions cannot reliably be made. As more data is collected, any length-related trends in fish condition will become more apparent.

Relative weight also did not differ significantly among levels of black spot severity, which indicates that black spot disease may not affect the health of juvenile *O. mykiss* in the Guadalupe River Watershed. The health effects of black spot disease on *O. mykiss* specifically have not been well-studied, and previous studies on salmonids and other freshwater species show mixed results regarding the extent to which the disease negatively impacts infected fish (Schaaf et al. 2017). For instance, Ferguson et al. (2012) found that it had no effect on juvenile coho salmon metabolism and growth, whereas studies with Centrarchids have found that it leads to significant weight loss and can be lethal at high infection levels (Hunter and Hamilton 1941, Lemly and Esch 1984). Though our results suggest that juvenile *O. mykiss* condition is not influenced by black spot severity, further data collection is warranted to draw reliable conclusions, especially since only 16% of the fish sampled had black spot and more than half of them had a severity level of 1. Continuing to assess the health effects of black spot disease in *O. mykiss* will be important given the potential for sub-lethal and lethal impacts reported in other species.

Mean W_r for all creeks was above 100, indicating that the *O. mykiss* populations were overall healthy. However, Calero Creek had the highest mean W_r and it was significantly greater than Guadalupe Creek, which suggests that the Calero Creek population was in the best condition in the Guadalupe Watershed in 2021. While relative weights of individuals in the Guadalupe River Watershed ranged widely, values show that the vast majority of fish are in excellent condition with 92% of fish sampled falling either within or above the optimal W_r target range (95−105).

Fish with a high W_r can signify a waterbody with conditions ideal for growth, such as suitable habitat and water quality, as well as abundant prey (Murphy et al. 1990, Liao et al. 1995). Presence of physical habitat features like large woody debris, boulders, and undercut banks can contribute to improved juvenile *O. mykiss* condition and survival by providing refugia from predators and high flow velocities. Our high W_r results suggest that environmental conditions in the Guadalupe River Watershed are favorable for juvenile *O. mykiss.* Salmonid creeks in the watershed are known to have habitat complexity in the form of large woody debris, boulders, rootwads, undercut banks, and emergent vegetation (Valley Water 2022).

Water temperature can likewise influence fish condition and has been documented to impact growth and size of *O. mykiss* and other salmonids through effects on metabolism, behavior and mortality (Bjornn and Reiser 1991). For example, young of the year *O. mykiss* fed to satiation exhibited increased growth rates at increased temperatures (up to 19ºC) in a laboratory setting (Myrick and Cech 2005), and both steelhead and coho salmon in a natural lagoon at the mouth of Scott Creek in Santa Cruz County showed positive growth rates when mean daily temperatures averaged >20ºC (Osterback et al. 2018). However, at extreme upper temperatures, growth may be reduced (Bjornn and Reiser 1991). According to NFMS (2016), optimal water temperatures for juvenile *O. mykiss* growth range from 12 to 19°C, though the majority of research done on suitable temperatures for salmonids has been conducted in the Pacific Northwest where environmental conditions are much different than the Central California Coast. Further, according to the National Oceanic and Atmospheric Administration's (NOAA's) National Integrated Drought Information System (NIDIS), Santa Clara County is currently categorized as "extreme drought," meaning that water supply is inadequate for agriculture, wildlife, and urban needs and reservoirs are extremely low. Drought conditions can have immediate effects on fish and invertebrate species' abundance, growth, survival, location in the watershed or migration capabilities. Effects to aquatic ecosystems may be short-term or long-lasting, depending on the severity and duration of the drought.

Earlier studies have also found relationships between W_r and food supply (Flickinger and Bulow 1993, Liao et al. 1995) and shown that prey biomass is positively correlated with fish condition. While Valley Water has not conducted any recent studies on *O. mykiss* prey abundance in the watershed, our high W_r results imply that adequately-sized prey items are readily available. *O. mykiss* feed on drifting and terrestrial insects, as well as bottom dwelling invertebrates, of all life stages (Moyle 2002). Benthic macroinvertebrate (BMI) studies conducted from 2009 to 2019 within the watershed found that the following prey sources in the following orders were present in Alamitos, Calero, and Guadalupe Creeks: Amphipoda, Coleoptera, Diptera, Ephemeroptera, Hemiptera, Hypsogastropoda, Megaloptera, Odonata, Plecoptera, Trichoptera, Trombidifores, and Venerida (CEDEN 2022).

Additionally, previous studies on salmonids have shown that fish weight or growth is inversely related to population density (Close and Anderson 1992, Keeley 2003), and that mean population W_r values are higher in areas where low densities of fish occur (Johnson et al. 1992). This is because individual fish weight and condition are likely to improve when there is reduced competition for food and other resources. During fall 2021 sampling, the estimated *O. mykiss* population densities in Alamitos and Guadalupe Creek were low compared to previous years at 0.02 *O. mykiss*/meter and 0.04 *O. mykiss*/meter, respectively (Valley Water 2022). The population density in Calero Creek, however, was the second highest estimated during the four-year sampling window (2018-2021) at an average of 0.23 *O. mykiss*/meter; Calero Creek also had the highest mean W_r. More definitive conclusions regarding the influence of density on fish condition in these systems can be made as sampling continues.

It is worth noting that human error has the potential to skew the results. Accurately measuring the length and weight of fish can be difficult in the field, especially with small fish and when they need to be measured quickly. Furthermore, issues taring the scale in the field and excess water on the equipment (scale and measuring board) can affect the weight measurement. Although the majority of individuals had a considerably high W_r, the results are within reason when compared to other populations of juvenile *O. mykiss* from Alaska through northern California. McLaughlin (2009) calculated the average W_r for over 100 juvenile *O. mykiss* populations of various sizes throughout northern California, Oregon, Washington, and Alaska. Average W_r for populations in McLaughlin's dataset ranged from 78.2 to 118.1 with an average of 97.7. The 2021 sampled populations in Alamitos, Calero, and Guadalupe Creeks had an average W_r of 106.3, 116.5, and 101.5, respectively, and thus fall above average within the aforementioned range.

Compared to previous sampling years in the Guadalupe Watershed, mean W_r for juvenile *O. mykiss* sampled in 2021 was similar to 2020 W_r for Alamitos and Guadalupe

Creeks, but still lower than in 2018 and 2019. On the other hand, the Calero Creek 2021 mean W_r was the second highest on record for Calero and only slightly below it's highest W_r (in 2018). There were no significant differences among sampling years on Alamitos Creek, which suggests that fish condition in this system has remained fairly stable over the past four years. For Calero Creek, mean W_r steadily declined from 2018 to 2020 then rose in 2021. The lowest year on record (2020) for Calero differed significantly from both 2018 and 2019 (the highest years). Guadalupe Creek mean W_r was comparable between 2018 and 2019 before it dropped significantly in 2020 and remained relatively low in 2021. Among all three creeks, Guadalupe Creek had the most interannual significant differences in mean W_r. Still, these results should be interpreted with caution as there are discrepancies in sample sizes between years. Any differences in W_r observed between sampling years can be due to a range of factors, such as variations in sampling procedures (e.g., sampling new stations) and environmental conditions (e.g., drought). Nevertheless, mean population relative weights equaled or exceeded 100, indicating that juvenile *O. mykiss* in all sampling years were in excellent condition.

With continued juvenile *O. mykiss* rearing sampling in the watershed, any climatic variation (e.g., dry, warm years vs. wet, cold years) and operational changes (e.g., flow releases or reductions) can also be incorporated into the results to determine if there is any correlation between these factors and fish condition. By using W_r as a condition index, we were able to make direct comparisons among fish of different lengths and across populations and years, and thus summarize the overall health of juvenile *O. mykiss* in the Guadalupe River Watershed. The W_r approach also provides future opportunities for comparisons to be made between these systems and other *O. mykiss* populations in Santa Clara County.

Overall, juvenile *O. mykiss* sampled in the Guadalupe River Watershed in 2021 and previous sampling years were healthy, indicating that environmental conditions within the watershed are favorable for supporting the growth and persistence of juvenile *O. mykiss*.

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Appendix A

Individual Measurements, Standard Weights (W_s), Relative Weights (W_r), and Black Spot Severity of *O. mykiss* Sampled During Fall 2021 Guadalupe River Watershed Juvenile Rearing Monitoring

FishID	Weight (g)	Fork-Length (mm)	W_s (g)	W_r (%)	Site	Black Spot Severity
Alamitos Creek						
2021ALM001	5.1	75	5.01	101.72	AC004	2
2021ALM002	5	75	5.01	99.72	ACBONUS	1
2021ALM003	8.2	84	6.99	117.36	ACBONUS	2
Calero Creek						
2021CAL001	2.5	61	2.74	91.30	CC002	0
2021CAL002	3.6	66	3.45	104.39	CC002	0
2021CAL003	9.4	85	7.23	129.95	CC002	0
2021CAL004	2.7	60	2.61	103.50	CC002	0
2021CAL005	2.5	57	2.24	111.36	CC002	0
2021CAL006	2.5	59	2.48	100.67	CC002	0
2021CAL007	6.1	77	5.42	112.64	CC002	0
2021CAL008	4.6	66	3.45	133.39	CC002	0
2021CAL009	6.9	74	4.82	143.13	CCBONUS	0
2021CAL010	4.9	71	4.27	114.74	CCBONUS	0
2021CAL011	6.8	79	5.84	116.48	CCBONUS	0
2021CAL012	81.5	182	67.22	121.25	CCBONUS	1
2021CAL013	4.5	65	3.30	136.46	CCBONUS	0
2021CAL014	3.4	65	3.30	103.10	CCBONUS	0
2021CAL015	4.3	69	3.93	109.48	CCBONUS	0
2021CAL016	3.8	68	3.76	100.97	CCBONUS	0
2021CAL017	3.6	65	3.30	109.17	CCBONUS	0
2021CAL018	5.8	74	4.82	120.31	CCBONUS	0
2021CAL019	7.7	78	5.62	136.91	CCBONUS	0
2021CAL020	5.7	74	4.82	118.24	CCBONUS	0
2021CAL021	10.9	89	8.28	131.71	CCBONUS	0
2021CAL022	7.8	84	6.99	111.64	CCBONUS	0
2021CAL023	7.5	84	6.99	107.34	CCBONUS	1
2021CAL024	8.4	85	7.23	116.13	CCBONUS	0
2021CAL025	5.4	72	4.45	121.37	CCBONUS	1
2021CAL026	5.1	70	4.10	124.49	CCBONUS	0
2021CAL027	6.7	78	5.62	119.13	CCBONUS	0
2021CAL028	11.4	95	10.02	113.80	CCBONUS	0

FishID	Weight (g)	Fork-Length (mm)	W_s (g)	W_r (%)	Site	Black Spot Severity
Guadalupe Creek						
2021GCK001	52.8	171	56.00	94.28	GC006	0
2021GCK002	6.1	81	6.28	97.11	GC005	0
2021GCK003	22.6	126	22.90	98.68	GC005	0
2021GCK004	18.8	120	19.85	94.69	GC003	0
2021GCK005	5.8	78	5.62	103.13	GC004	0
2021GCK006	7.6	81	6.28	121.00	GC004	0

Guadalupe River Watershed *Oncorhynchus mykiss* 2020 – 2021 Migration Monitoring Using Passive Integrated Transponder Tags

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Contents

Introduction ... 1

Methods ... 2

- Fish PIT Tagging and Numbers of Tagged Individuals ... 2
- Antenna Construction and Operation ... 5
  - Alamitos Creek Antenna ... 5
  - Guadalupe Creek Antennas ... 7
  - Guadalupe River Antenna ... 11

Results and Discussion ... 14

- Alamitos Creek Antenna ... 14
- Guadalupe Creek Antenna ... 18
- Guadalupe River Antenna ... 22

Conclusion ... 25

References ... 27

Tables

Table 1: Total fish tagged with PIT tags in the Guadalupe Watershed by creek. ... 3

Table 2. Guadalupe Creek antennas recorded outage type and duration during the 2020-2021 monitoring period. ... 9

Table 3. Guadalupe River antenna recorded outage type and duration during the 2020-2021 monitoring period. ... 13

Table 4. O. mykiss tag number and associated information of each fish detected at the Alamitos Creek antenna during the 2020-2021 migration season. ... 15

Table 5. O. mykiss tag number and associated information of each fish detected at the Guadalupe Creek antennas during the 2020-2021 migration season. ... 19

Table 6. O. mykiss tag number and associated information of each fish detected at the Guadalupe River antenna during the 2020-2021 migration season. ... 22

Figures

Figure 1. 12 mm (top) and 23 mm (bottom) HDX PIT tags. ... 3

Figure 2. PIT tagging sampling stations from the 2018 -2021 juvenile O. mykiss rearing study in the Guadalupe River Watershed. AC005 was not sampled in 2018 and Alamitos antenna was not sampled in 2019 (Due to the scale of this map, it is challenging to see this station behind the

Alamitos Creek PIT antenna station. AC005, CC003, GC001, GC002, GR002, LG001 and LG002 were not sampled in 2021 due to homeless encampments and dry channel conditions.. 4
Figure 3. Swim-over antenna at Alamitos Creek installed in a groove of the wood vortex weir… 6
Figure 4. Swim-through antenna (A1) at Guadalupe Creek. Arrows point to the location, as the single loop of wire is difficult to see in the image. 8
Figure 5. Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag average read ranges at the Guadalupe Creek antenna A1. 10
Figure 6. Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag average read ranges at the Guadalupe Creek antenna A2. 10
Figure 7: Swim-through antenna at Guadalupe River…..12
Figure 8: Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag average read ranges at the Guadalupe River antenna. 14
Figure 9. O. mykiss tagging locations and relative paths to the Alamitos Creek antenna. Numbers in legend indicate last four digits of O. mykiss PIT tag number. O. mykiss #6857 and 6584, both tagged at the Alamitos antenna station, are not shown on the map as the PIT antenna and tagging location are the same and thus relative path cannot be determined. 16
Figure 10. O. mykiss tracked by the Alamitos Creek antenna compared to average daily flow on Alamitos Creek at Greystone (ALERT 5070) Stream Gage. Flow was high enough during the late-January storm that fish traveling in the upper half of the water column could have avoided detection. 18
Figure 11. O. mykiss tagging locations in Guadalupe Creek and relative path of O. mykiss #6130 to the Guadalupe Creek antennas. 20
Figure 12. O. mykiss tracked on Guadalupe Creek compared to average daily flow on Guadalupe Creek at Hicks Road (ALERT 5043) Stream Gage and antenna outages. Partial outages indicate that one antenna was still operational. Numbers in legend indicate the last four digits of O. mykiss PIT tag numbers. 21
Figure 13. O. mykiss #9222 tagging location on Guadalupe Creek and relative path to the Guadalupe River antenna. 23
Figure 14. O. mykiss tracked on the Guadalupe River antenna compared to average daily flow on Guadalupe River at USGS Stream Gage (11169025) and antenna outages. Transparency was added to the points to better decipher movement of the single individual detected on the antenna. Numbers in legend indicate the last four digits of O. mykiss PIT tag numbers. 24

Appendices

Appendix A: PIT Tag Master List

Introduction

The Guadalupe River Watershed begins in headwater tributaries near the summits of Loma Prieta and Mount Umunhum, with the mainstem Guadalupe River draining into South San Francisco Bay via Alviso Slough, west of Alviso Marina County Park. Major tributaries in the Guadalupe River include Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek. The federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) persists in these systems, and the Guadalupe River is designated critical habitat between its confluence with San Francisco Bay and West Hedding Street in San Jose (70 FR 52570, September 2005).

To better understand the movement and migration of *O. mykiss* in the Guadalupe River Watershed, Valley Water implemented a Passive Integrated Transponder (PIT) monitoring program. Specifically, this monitoring should improve the knowledge of *O. mykiss* migratory timing, behavior, and proportion of the tagged population showing migratory tendencies as a whole and within each sub-watershed.

A PIT tag is a small radio transponder that contains a specific code, which allows individual fish to be assigned a unique identification number. It is a passive device in that they do not require a battery to produce a signal; rather, a radio-frequency identification (RFID) system sends a radio frequency into the environment. When a PIT tag is within range and detected by the tag reading system, the unique identification code is relayed to the system along with date and time information. There are two different types of PIT tags - half-duplex (HDX) and full-duplex (FDX). HDX tags were chosen for this study as they are better suited to handle environmental noise typical of an urban environment. HDX PIT tags are charged wirelessly by short magnetic pulses that are emitted when in the vicinity of HDX readers, which are installed as a component of a PIT antenna array. When the reader stops sending the charge field, the tag uses the stored power to send the tag number back to the reader without interference from the reader. One stationary tag reading system was deployed on Guadalupe River, and Alamitos Creek allowing for movement of *O. mykiss* to be detected as fish passed over the antennas. Two stationary antennas were installed in close proximity on Guadalupe Creek to capture directionality of movement. In 2018, Valley Water began injecting PIT tags into *O. mykiss* meeting the minimum size requirements (≥ 65 mm) during annual juvenile *O. mykiss* rearing monitoring. A total of 63 *O. mykiss* were collected and tagged in 2020 in the Guadalupe River Watershed, and a total of 270 *O. mykiss* have been tagged since 2018 (Valley Water 2019, Valley Water 2020a, and Valley Water 2021).

Methods

Fish PIT Tagging and Numbers of Tagged Individuals

Juvenile *O. mykiss* rearing monitoring is conducted annually in the fall in the Guadalupe River Watershed, typically at 24 sampling stations (Figure 2). Due to drought conditions and other constraints in fall of 2021, sampling was only conducted at 19 stations: three on Guadalupe River, five on Guadalupe Creek, three on Los Gatos Creek, five on Alamitos Creek, and three on Calero Creek. Multi-pass depletion backpack electrofishing was conducted in October and November at each station to determine the presence of *O. mykiss* as well as the composition of other fish species in the Guadalupe River Watershed (Valley Water 2019 and Valley Water 2020a). *O. mykiss* with a fork-length (FL) of 65 mm or greater were tagged during each sampling event. *O. mykiss* with a FL greater than or equal to 65 mm but less than 150 mm received a 12 mm HDX PIT tag, while *O. mykiss* with a FL of 150 mm or greater received a 23 mm HDX PIT tag (Figure 1). All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 1999) by staff trained in the procedure.

A total of 270 *O. mykiss* were tagged in the Guadalupe River Watershed between 2018 and 2020. Of these, 252 were tagged with 12 mm tags and 18 were tagged with 23 mm tags. A summary of tagging numbers by creek is provided in Table 1. No *O. mykiss* have been observed or tagged on Los Gatos Creek since monitoring began in 2018. Tagging locations are displayed in Figure 2. PIT tag numbers and associated biological data for all fish tagged by Valley Water in Santa Clara County are included in Appendix A.

Table 1: Total fish tagged with PIT tags in the Guadalupe Watershed by creek.

Year	**Alamitos Creek**	**Calero Creek**	**Guadalupe Creek**	**Guadalupe River**	**Total**
2018	58	17	50	0	125
2019	45	7	29	1	82
2020	22	30	11	0	63
Total	125	54	90	1	270

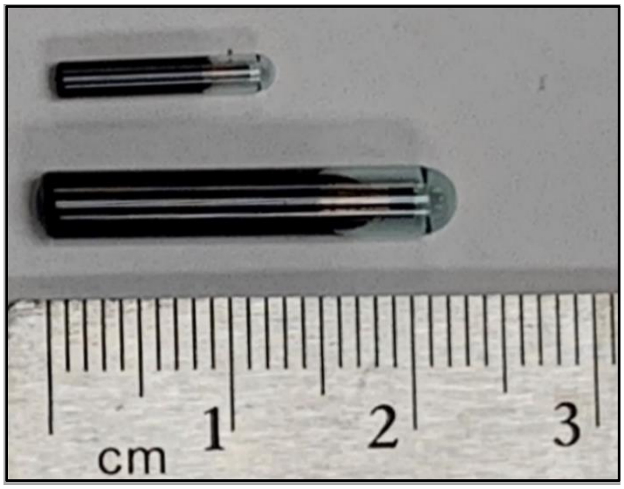

Figure 1. 12 mm (top) and 23 mm (bottom) HDX PIT tags.

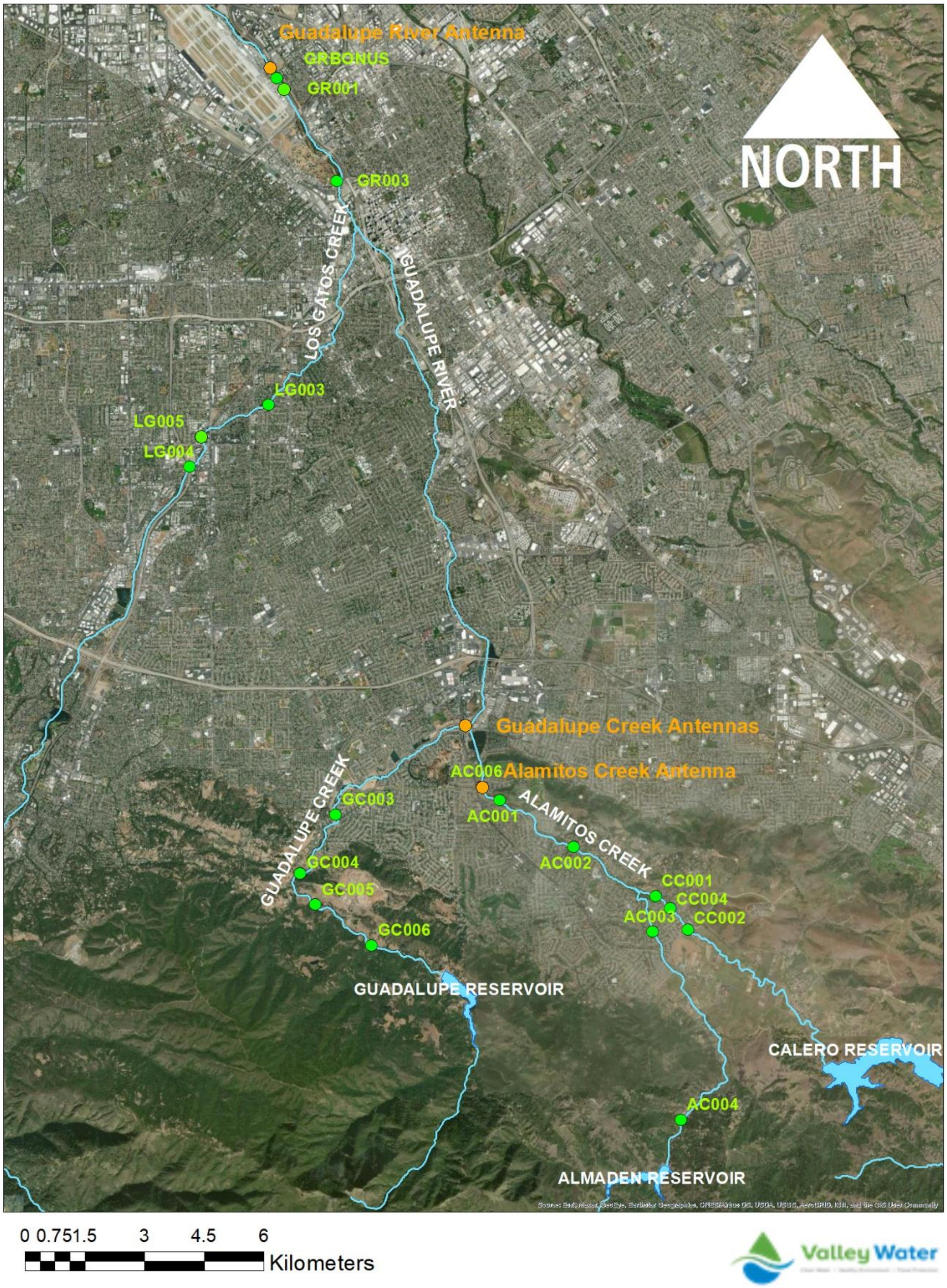

Figure 2. PIT tagging sampling stations and PIT tag arrays from the 2021 juvenile O. mykiss rearing study in the Guadalupe River Watershed.

Antenna Construction and Operation

Antennas installed in the Guadalupe River Watershed used HDX RFID technology. The basic components of the HDX arrays included an RFID reader, a power source, a tuning capacitor, and an antenna (Oregon RFID, 2021). When readers detected a PIT tag, they stored the following detection data: PIT tag number, date and time stamp, number of times the tag was detected (number of consecutive scans that detected the tag), and number of scans since last detection. Single PIT antenna stations were installed on Alamitos Creek and Guadalupe River. Detections recorded by these antennas indicated that a tagged individual was in proximity of the antenna at a given time but did not indicate direction of movement. Therefore, assumptions were made about direction based on the release point after tagging occurred, timing, and the position of the antenna in the watershed. The antenna on Guadalupe River is low enough in the system that a fish passing over that antenna could be assumed to be out-migrating. The Guadalupe River antenna was installed by FISHBIO and maintained by Valley Water. Assumptions were also made that detections were of the target species and not tags that were either expelled and mobile in the system nor were in the digestive system of a predatory species. A directional antenna array, consisting of two antennas was installed on Guadalupe Creek. Having two antennas at one station allows for movement to be determined, by seeing which antenna the detection occurred on first, if the fish was detected by both antennas. The Alamitos Creek and Guadalupe Creek antennas were installed and maintained by Valley Water; specifics of the antennas are described below.

Alamitos Creek Antenna

The Alamitos Creek antenna was installed on November 26, 2018, and thus the WY 2021 monitoring period was the third *O. mykiss* migration season for which this antenna was deployed. This antenna is located downstream of the Calero Creek confluence, which provides the ability to detect potential outmigration that is occurring from both the Calero and Alamitos Creeks sub-watersheds. The antenna is approximately 10 m long by 0.4 m wide with a swim-over design. The antenna consists of a single loop of 8 American wire gauge (AWG) copper wire passed through a plastic conduit that was fitted directly into a groove, cut specifically to hold the antenna, in a wood vortex weir (Figure 3). The weir was installed as part of the Valley Water Stream Maintenance Program (SMP) Alamitos Creek Instream Habitat Complexity Project that included large woody debris implementation and gravel augmentation. Plastic strappings and ceramic covered screws were used to secure the conduit in an attempt to reduce electrical noise and interference caused by metal near the antenna. The antenna is powered by a 120-volt wired receptacle and connected to a 12-volt power inverter.

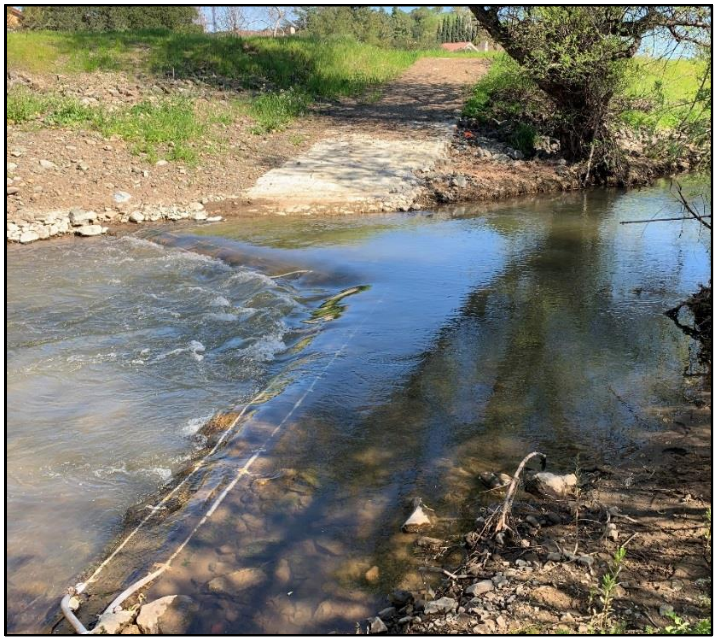

Figure 3. Swim-over antenna at Alamitos Creek installed in a groove of the wood vortex weir.

The antenna provided complete lateral coverage of the channel during winter base flows, but during storm events some areas along the channel margin were not within a detectable range of the antenna. The average read ranges for PIT tags directly above the antenna were 18 cm for 12 mm PIT tags and 20 cm for 23 mm PIT tags. The average read ranges up- and downstream of the antenna were 3 cm and 8 cm for the 12 mm and the 23 mm tags, respectively. No antenna power outages or other failures occurred during the 2020-2021 *O. mykiss* migration monitoring season.

Estimates of the portion of the water column effectively scanned were made using physical measurements of PIT tag read ranges and outputs from the Hydrologic Engineering Center's River Analysis System (HEC-RAS), a computer program that models the hydraulics of water flow through a system, for hydraulic modeling in the Alamitos Creek sub-watershed. This data was reported in a figure in the Guadalupe River Watershed *Oncorhynchus mykiss* Migration Monitoring Using Passive Integrated Transponder Tags: Pilot Study report (Valley Water 2020b); however, it was deemed inaccurate this monitoring season as the wood vortex weir is not geomorphologically similar to any of the transects measured along Alamitos Creek.

The antenna read range was field verified at 10.4 cfs (Alamitos Creek at Graystone Ln, ALERT 5070) in 2020. The antenna provided complete coverage for both the 12 mm and 23 mm PIT tags well above the water depth of 12.5 cm directly above the antenna at the time of measurement. The antenna read range was field verified at a flow of 41.8 cfs. At the time of measurement, the depth of the channel at the thalweg was 30 cm. The 12mm tag had a read range of 12 cm above the antenna and the 13mm tag had a read range of 30 cm. At flows around this magnitude the antenna provided full coverage for 23 mm tags, but 12 mm tags could only be detected in the lower half of the water column. Flows exceeded 41 cfs on seven days in January and February in 2021.

Guadalupe Creek Antennas

The Guadalupe Creek antenna station was established upstream of the confluence with Guadalupe River in 2018. The 2020-2021 monitoring period was the third season of *O. mykiss* migration during which this station was monitored. On December 3, 2020 a directional antenna array was set up, with a second antenna installed 4.6 m downstream of the original antenna. This allows for potentially determining direction of movement and improve detection efficiency. Both antennas are a swim-through design consisting of a single loop of 10 AWG copper wire. The upstream antenna (A1) is 10.3 m by 0.8 m and the downstream antenna (A2) is 10.4 m by 1.1 m. The top of the antennas is supported with a static line and ratchet strap between two anchoring points, and the bottom is anchored into the channel substrate with round nail stakes (Figure 4).

Zip-ties were used to attach the wire to the stakes to reduce direct contact with metal and hold the wire to the static line. Unlike the Alamitos Creek antenna, these wires are not encased in plastic conduit. The antennas are powered by a 120-volt wired receptacle connected to a 12-volt power inverter. Additionally, marker tags, programmed to be detected every 30 minutes, were installed inside the detection zone of the antenna. This verified continuous antenna operation and demarcated the timing of outages.

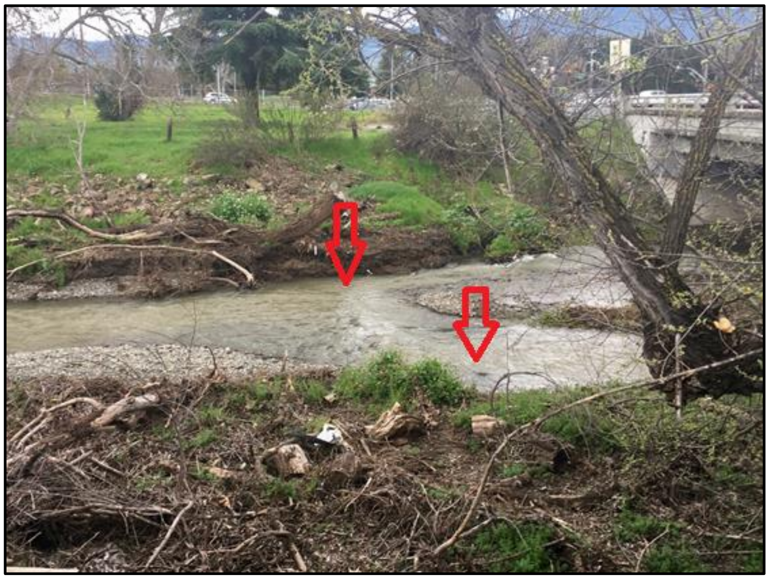

Figure 4. Swim-through antenna (A1) at Guadalupe Creek. Arrows point to the location, as the single loop of wire is difficult to see in the image.

The antennas provided complete lateral coverage of the channel during most flows, but during large storm events when the floodplain was inundated some areas along the channel margin were not detectable. The read range of A1 consistently spanned the entire height of the antenna between the top and bottom wires (0.8 m) for the 23 mm and 12 mm tags. The average read ranges up- and downstream of the antenna were typically 3 cm and 36 cm for the 12 mm and the 23 mm tags, respectively. The average read ranges above the antenna were 38 cm for the 23 mm tags and 15 cm for the 12 mm tags. The read range of A2 consistently spanned the entire height of the antenna between top and bottom wires (1.07 m) for the 23 mm tags. The 12 mm tags had an average read range of 33 cm, which created a 41 cm dead zone in the middle of the antenna. The average read range up- and downstream of the antenna was 13 cm for the 12 mm tag and between 20 and 33 cm for the 23 mm tags. The average read range above A2 was 18 cm for the 12 mm tag and 58 cm for the 23 mm tag. Outages occurred as a result of reader failure (Table 2).

Table 2. Guadalupe Creek antennas recorded outage type and duration during the 2020-2021 monitoring period.

Outage Type	Antenna	Outage Start*	Outage End*
Complete	A1	04/06/2021 00:30	04/12/2021 12:30
Complete	A1	04/24/2021 07:30	04/26/2021 12:00
*Estimated to the nearest half hour based off reader outputs or marker tag detections.			

Estimates of the portion of the water column effectively scanned were made using physically measured PIT tag read ranges and outputs from the HEC-RAS hydraulic modeling in the Guadalupe Creek sub-watershed. The antenna A1 was installed within a riffle; therefore, the nearest cross-section at a riffle crest was used as a reference. Based on the modeling results, it is estimated that A1 provided complete coverage of the entire water column above the antenna up to 450 cfs (ALERT 5043) for the 12 mm tags and at all modeled flows for the 23 mm tags (Figure 5). A2 was installed within a run; therefore the centroid of the flatwater cross-sections in the area was used as a reference. Estimates for A2 indicate that the antenna provided coverage up to 15 cfs and partial coverage (due to the dead zone) over 15 cfs for 12 mm tags. Additionally, A2 provided complete coverage at any modeled flow for 23 mm tags (Figure 6). These results do not account for inundation of the floodplain on either side of the antenna.

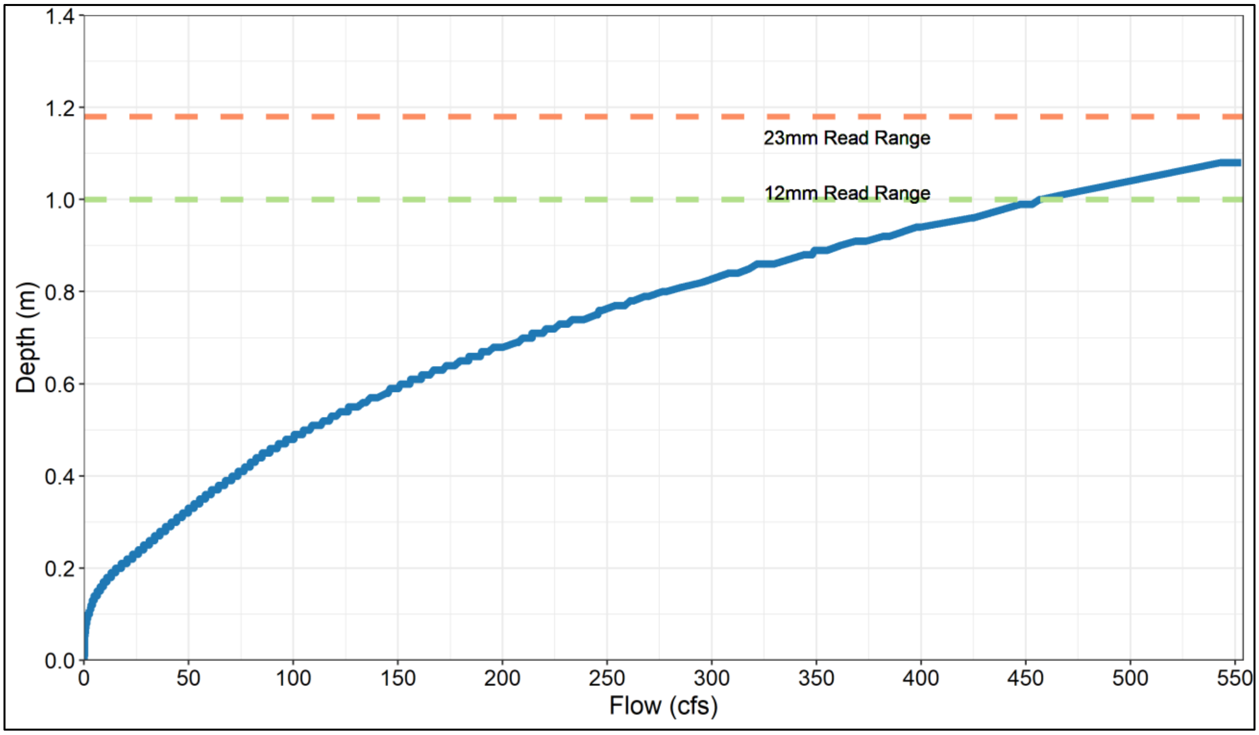

Figure 5. Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag average read ranges at the Guadalupe Creek antenna A1.

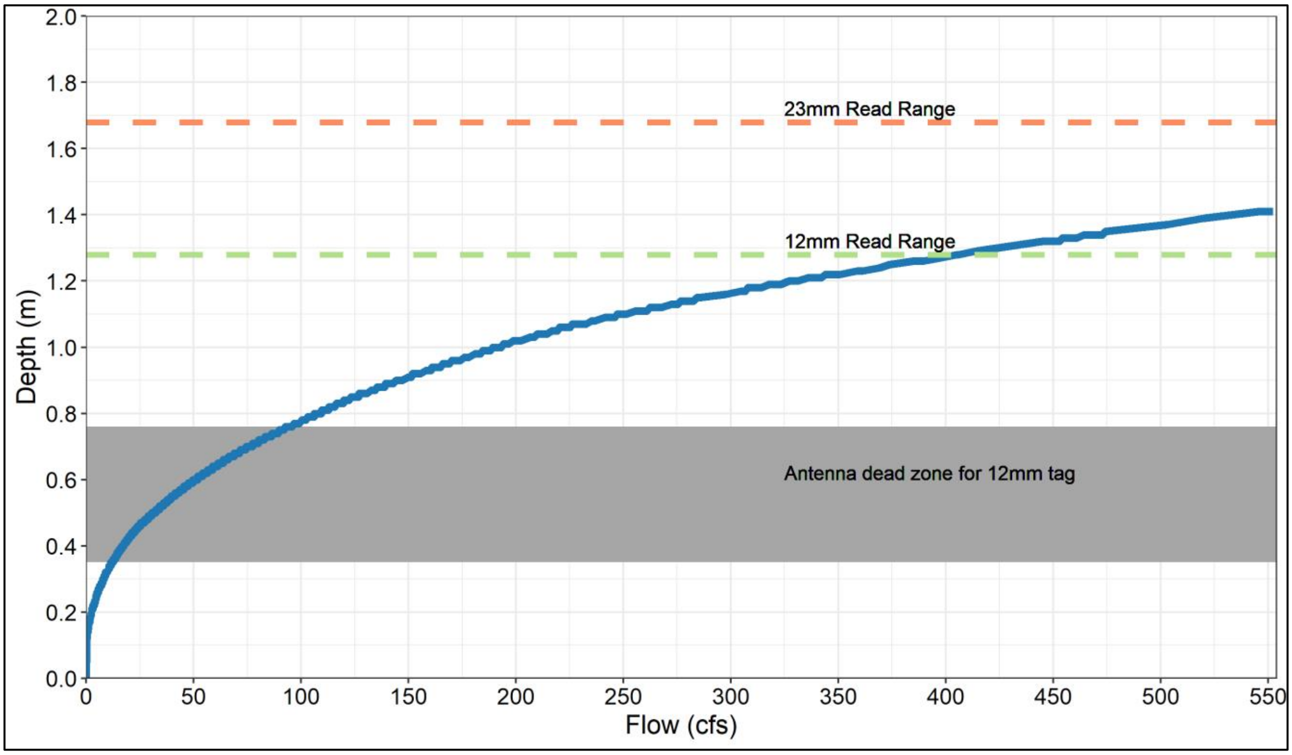

Figure 6. Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag average read ranges at the Guadalupe Creek antenna A2.

Guadalupe River Antenna

The Guadalupe River antenna station is located near Airport Parkway and has been in operation since 2018. The 2020-2021 monitoring period was the third season of *O. mykiss* migration during which an antenna was deployed.. The antenna currently measures 7.3 m wide and 0.8 m tall and consists of two loops of 10 AWG wire encased in PVC tubing. The top of the antenna is supported with a static line between two anchoring points, and the bottom is anchored to the concrete substrate (Figure 7). The antenna was powered by four 6-volt batteries connected to produce 12 volts of power. Additionally, a marker tag, programmed to be detected every 30 minutes, was installed inside the detection zone of the antenna. This verified continuous antenna operation and demarcated the timing of outages. For the 2020-2021 monitoring period, FISHBIO installed the antenna and made repairs as needed. Valley Water performed the data downloads and maintained the antenna array on a weekly basis.

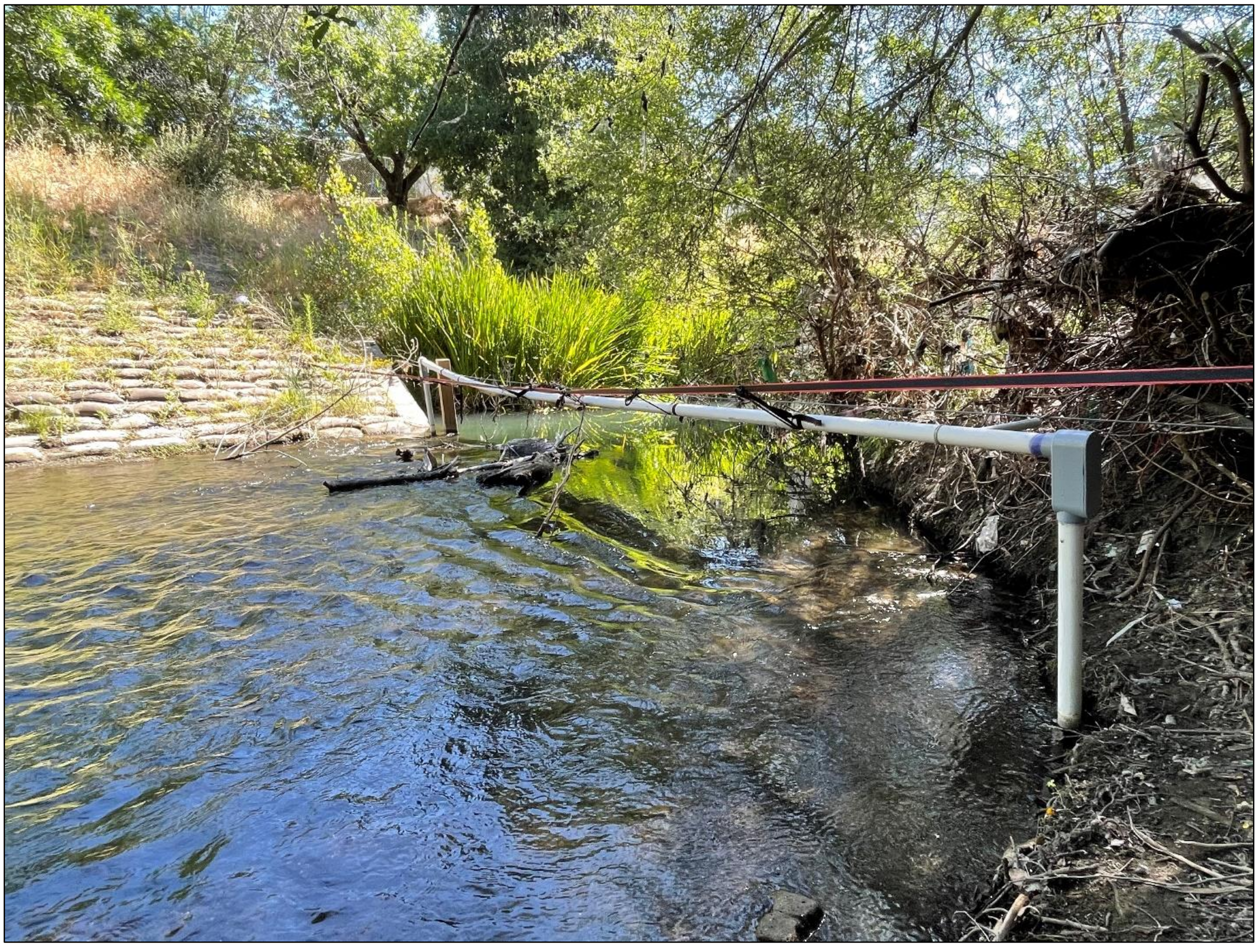

Figure 7: Swim-through antenna at Guadalupe River.

The antennas provided complete lateral coverage of the channel during most flows, but during large storm events when the floodplain was inundated some areas along the channel margin were not detectable. The read range consistently spanned the entire height of the antenna between the top and bottom wires (0.8 m) for the 23 mm and 12 mm tags. The average read ranges up- and downstream of the antenna were typically 15 cm and 30 cm for the 12 mm tags and 15 cm and 46 cm for the 23 mm tags, respectively. The average read ranges above the antenna were 38 cm for the 23 mm tags and 15 cm for the 12 mm tags. Outages occurred in January, February, and March as a result of reader failure (Table 3).

Table 3. Guadalupe River antenna recorded outage type and duration during the 2020-2021 monitoring period.

Outage Type	Antenna	Outage Start*	Outage End*
Complete	GDR1	01/08/2021 12:00am	01/22/2021 09:30am
Complete	GDR1	01/27/2021 02:00am	02/10/2021 02:00pm
Complete	GDR1	02/24/2021 10:00pm	03/01/2021 09:00am
Complete	GDR1	03/05/2021 06:30am	03/08/2021 01:30pm
Complete	GDR1	03/12/2021 11:30am	03/15/2021 08:00am

*Estimated to the nearest half hour based on reader outputs or marker tag detections.

Estimates of the portion of the water column effectively scanned were made using physical measurements of PIT tag read ranges and outputs from the HEC-RAS hydraulic modeling in the Guadalupe River watershed. The antennas were installed within a riffle, so the nearest cross section at a riffle crest was used as reference. Based on the modeling results, it is estimated that the antenna provided complete coverage of the entire water column above the antenna up to 300 cfs for the 12 mm tags and up to 500 cfs (USGS Gage 1169025) for the 23 mm tags (Figure 8). These results do not account for inundation of the floodplain on either side of the antenna.

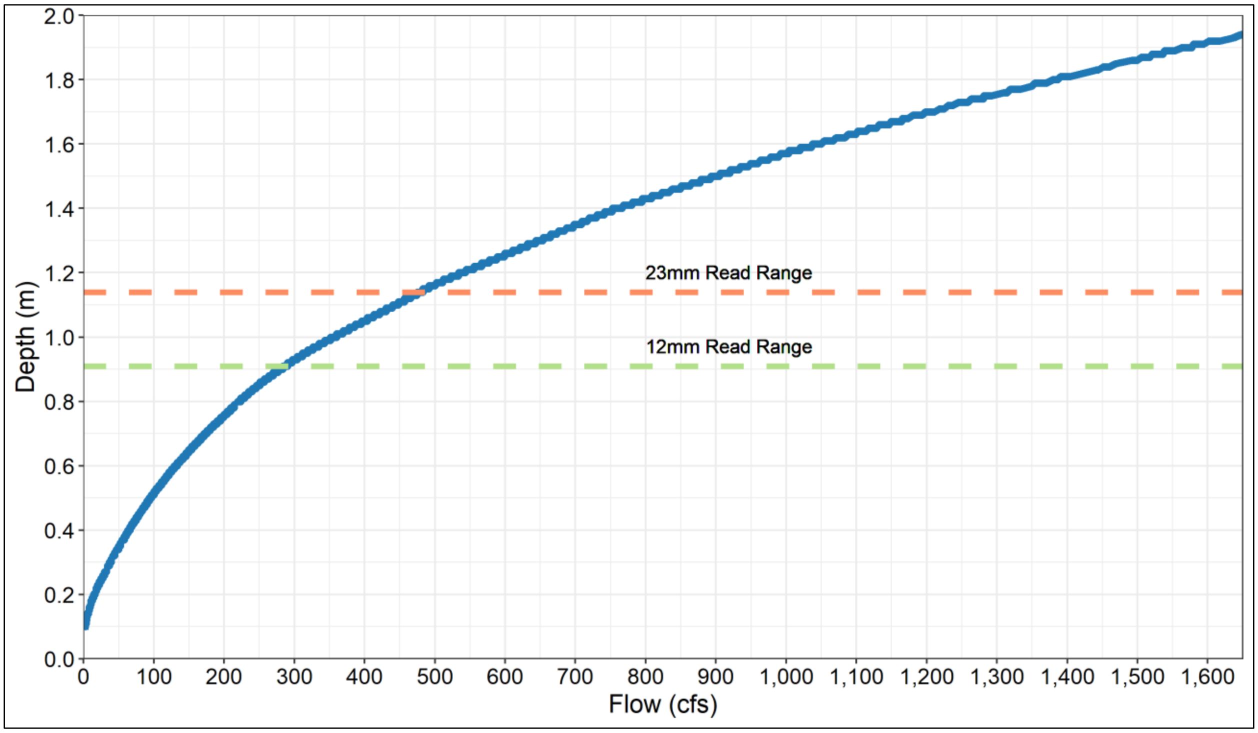

Figure 8: Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag average read ranges at the Guadalupe River antenna.

Results and Discussion

This monitoring report is for the 2020-2021 *O. mykiss* migration season. Therefore, the results presented below contain data collected from October 1, 2020 to May 31, 2021.

Alamitos Creek Antenna

A total of four individual tags, all injected in *O. mykiss* by Valley Water, were detected at the Alamitos Creek antenna during the 2020-2021 migration season (Table 4). Three of the four tags were from *O. mykiss* tagged in Alamitos Creek and one was tagged on Calero Creek. One of the tags detected was a 23 mm tag and three of the tags were 12 mm tags. Relative paths of detected *O. mykiss* from their tagging locations to the Alamitos Creek antenna are shown in Figure 9.

Table 4. O. mykiss tag number and associated information of each fish detected at the Alamitos Creek antenna during the 2020-2021 migration season.

Date Tagged	**Date Last Detected**	**Tag ID**	**Creek**	**Tagging Station**	**Fork-length (mm)**
11/9/2020	12/8/2020	982.12605814**6854**	Alamitos Creek	SMP ALM Mazzone	138
11/9/2020	3/26/2021	900.22800061**3752**	Alamitos Creek	AC001	240
11/2/2020	4/3/2021	982.12605814**6859**	Calero Creek	CC003	70
11/9/2020	4/7/2021	982.12605814**6857**	Alamitos Creek	SMP ALM Mazzone	95

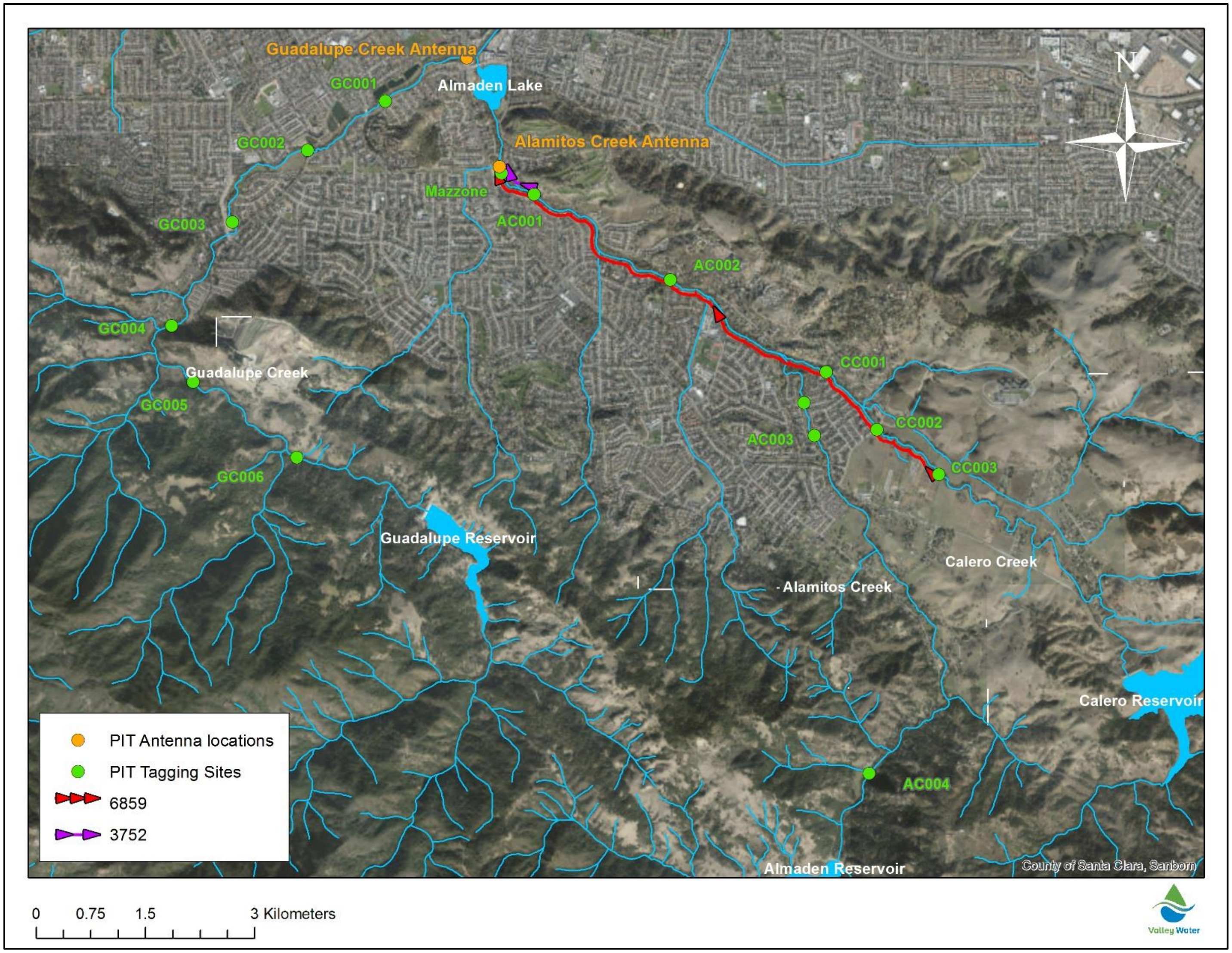

Figure 9. O. mykiss tagging locations and relative paths to the Alamitos Creek antenna. Numbers in legend indicate last four digits of O. mykiss PIT tag number. O. mykiss #6857 and 6584, both tagged at the Alamitos antenna station, are not shown on the map as the PIT antenna and tagging location are the same and thus relative path cannot be determined.

The *O. mykiss* detected ranged in size from 70 to 240 mm FL when tagged. These lengths were recorded one to five months prior to the detection date. Each of these fish was tagged in 2020; no fish were detected from previous tagging seasons. According to Moyle (2002), in small streams with low summer flows, like systems in the Guadalupe River Watershed, young-of-the-year (age 0) steelhead measure 50–90 mm, and fish at the end of their second year (age 1) measure 100–160 mm. Smith and Leicester (2016) aged 32 fish from Guadalupe Creek and found that young-of-the-year (YOY) *O. mykiss* ranged from 85–114 mm, and fish in their second year ranged from 110–195 mm. This is a faster growth rate than predicted by Moyle (2002), but this is expected in warmer, more productive systems. Based on Moyle (2002) and Smith and Leicester (2016), the *O. mykiss* detected by the Alamitos Creek antenna were YOY (#6857, 6859; last four digits of PIT tag identification number), in their second year (#6854), or third year (#3752).

O. mykiss #6857 was the only fish to be detected multiple times during the migration season (Figure 10). Fish #6857 (FL 95) was first detected on December 7 and continued to be detected throughout the monitoring season with the final detection on April 7, 2021. This fish appeared to be utilizing the restored habitat from the SMP Alamitos Creek Instream Habitat Complexity Project and did not appear to have migratory tendencies, though that cannot be confirmed. The other three *O. mykiss* (#6859, 6854, 3752) were each only detected on a single day during the migration season. This is typical while out-migrating or showing other migratory tendencies. The majority of *O. mykiss* movement at the Alamitos Creek antenna occurred later in the season on a very gradual descent of the hydrograph (Figure 10). With the exception of one detection of fish #6857 at 68 cfs in late January on the ascending limb of the hydrograph, all other detections occurred at flows under 12 cfs. Due to the drought conditions very few rain events were present that increased flow. Early season (early December) movement by fish #6854 did not appear to coincide with any storm or increased flow events and it is unclear whether this movement was migratory or local. This fish was also captured and released in close proximity of the antenna, which could have resulted in this detection.

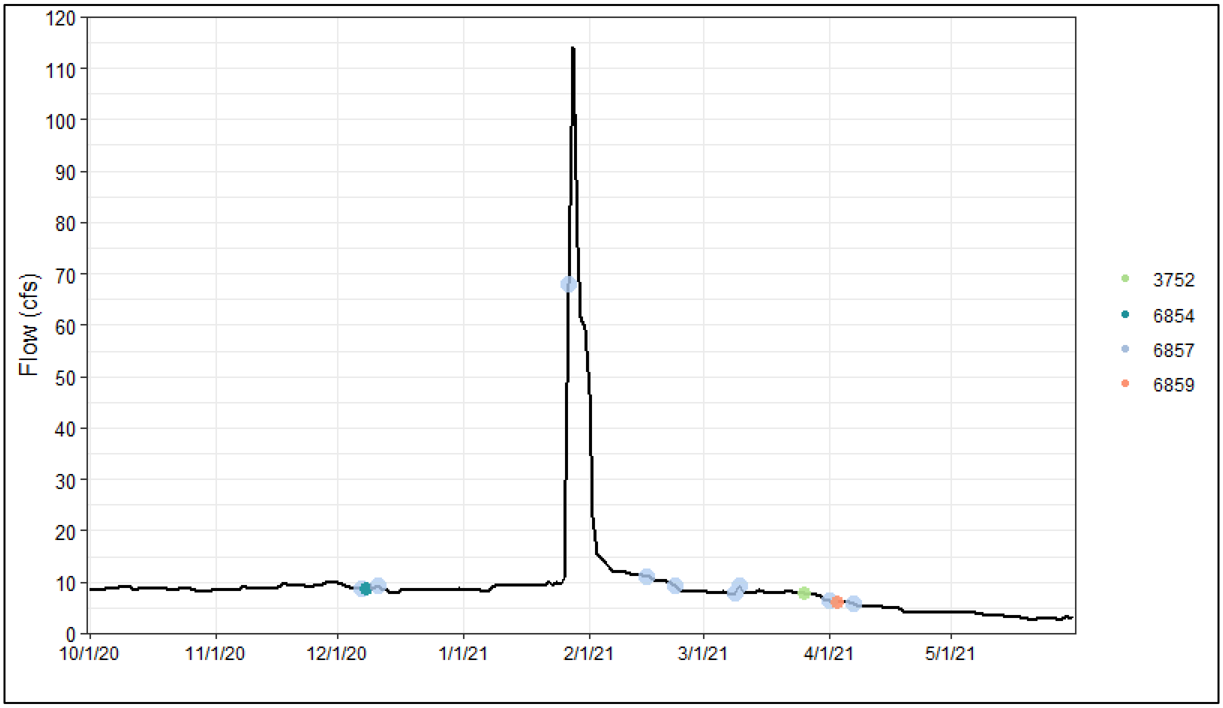

Figure 10. O. mykiss tracked by the Alamitos Creek antenna compared to average daily flow on Alamitos Creek at Greystone (ALERT 5070) Stream Gage. Flow was high enough during the late-January storm that fish traveling in the upper half of the water column could have avoided detection.

The repeated detection of *O. mykiss* #6857 provides evidence of the success of the SMP Alamitos Creek Instream Habitat Complexity Project and shows that fish are utilizing the habitat within the first- and second-year post-construction in a wide range of flows.

Guadalupe Creek Antenna

The two Guadalupe Creek antennas were located at the very downstream end of the system, before the confluence with the Guadalupe River. The duality of the antennas at Guadalupe Creek can help determine the direction of movement and improve detection efficiency. One *O. mykiss* (FL = 82) tagged at GC005 was detected at the Guadalupe Creek antenna (A2) during the 2020-2021 migration season (Table 5). The relative path of *O. mykiss* #6130 from the tagging location at GC005 to the Guadalupe Creek antennas is shown in Figure 11. This fish was only detected at one of the antennas, so confirmation on the direction of movement is not possible.

Table 5. O. mykiss tag number and associated information of each fish detected at the Guadalupe Creek antennas during the 2020-2021 migration season. Fish #6130 was only detected on antenna A2.

Date Tagged	Date Last Detected	Tag ID	Creek	Tagging Station	Fork-length (mm)
10/21/2020	3/10/2021	982.12605814**6130**	Guadalupe Creek	GC005	82

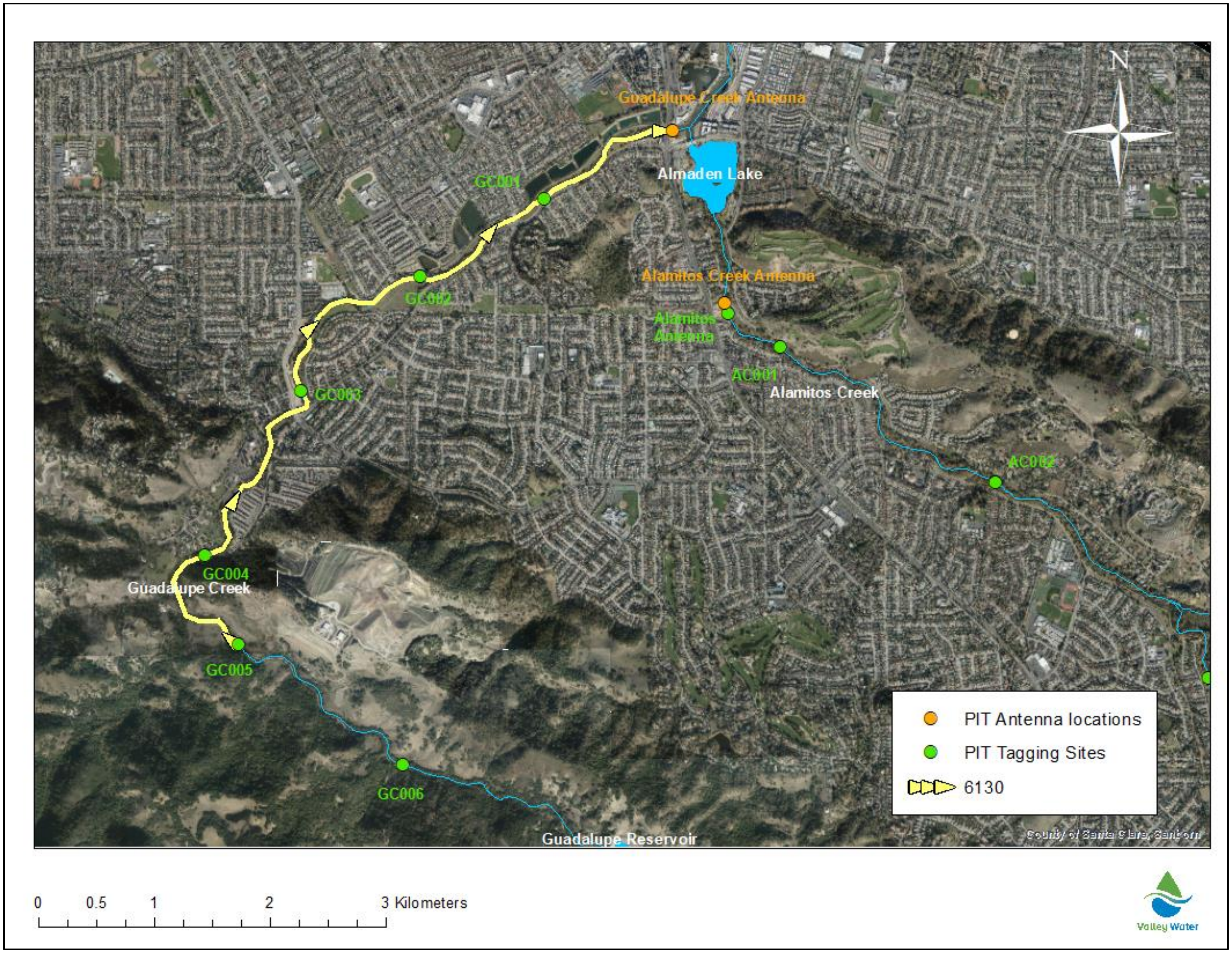

Figure 11. O. mykiss tagging locations in Guadalupe Creek and relative path of O. mykiss #6130 to the Guadalupe Creek antennas.

O. mykiss were not detected by the Guadalupe Creek antennas until March after the first and only large storm event of the season (Figure 12). Movement did not appear to be associated with the declining limb of the hydrograph. The only movement detected by the Guadalupe Creek antennas occurred at 1.7 cfs (ALERT 5043) on March 10, 2021. Antenna A1 experienced two complete outages in April totaling 208.5 hours. Stream flow at the fish ladder at Masson Dam (ALERT 5114) was <0.2cfs during the period of these outages. Due to these extremely low flow conditions migration during this time was unlikely.

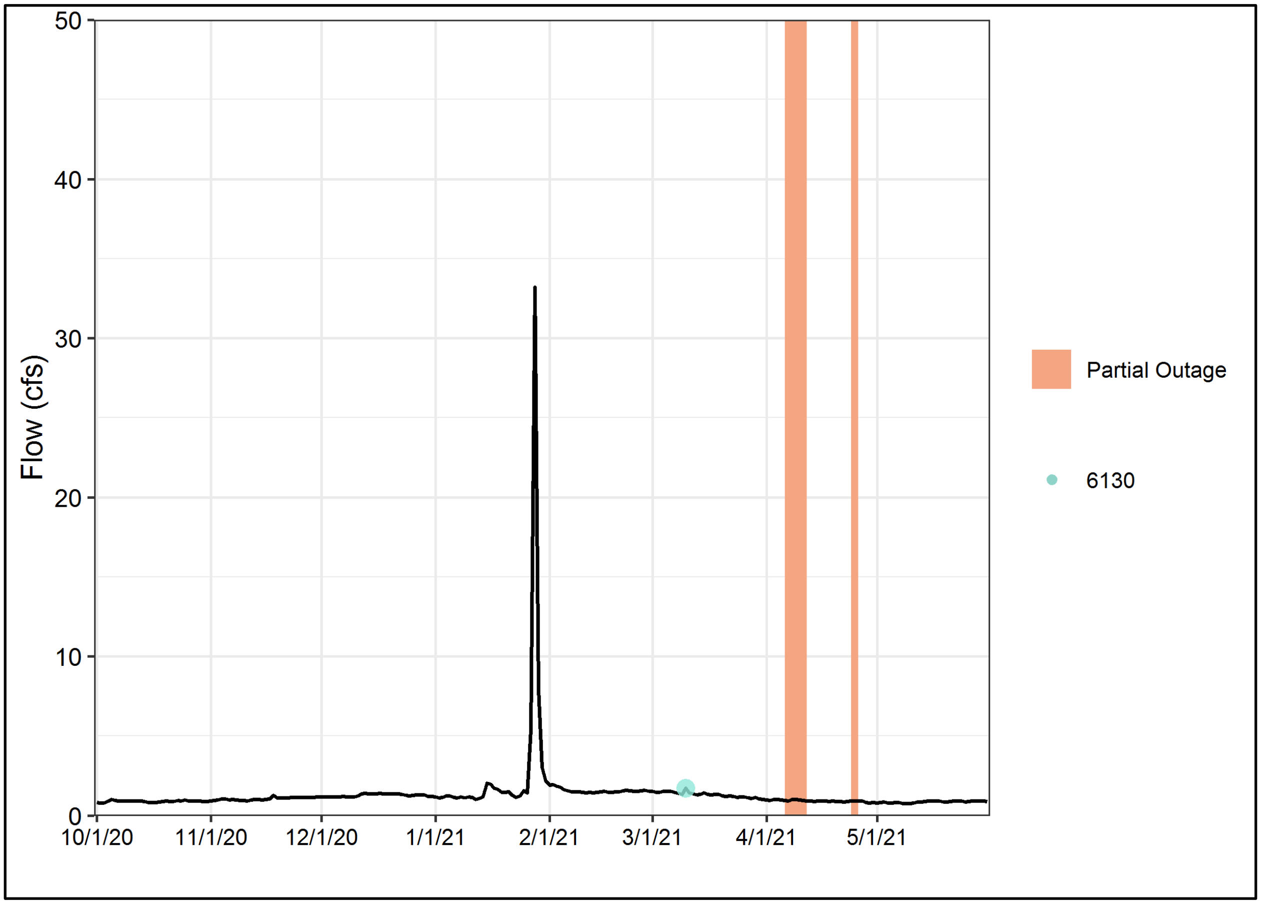

Figure 12. O. mykiss tracked on Guadalupe Creek compared to average daily flow on Guadalupe Creek at Hicks Road (ALERT 5043) Stream Gage and antenna outages. Partial outages indicate that one antenna was still operational. Numbers in legend indicate the last four digits of O. mykiss PIT tag numbers.

The *O. mykiss* (#6130) detected in Guadalupe Creek was 82 mm in FL when tagged. Based on Moyle (2002), *O. mykiss* #6130 was YOY when tagged; this age estimate is corroborated by Smith and Leicester (2016). This length was recorded five months prior to the detection date, so the fish was likely larger at detection than when tagged. As this fish was detected only once it is assumed that it was showing migratory tendencies.

Guadalupe River Antenna

With the position of the antenna in a migratory corridor and the general lack of *O. mykiss* capture in Guadalupe River, it's assumed detections on this antenna are of *O. mykiss* exhibiting migratory tendencies. One *O. mykiss* (#9222), tagged in Guadalupe Creek in 2019, was detected at the Guadalupe River antenna in WY 2021 (Table 6). The relative path of *O. mykiss* #9222 from the tagging location at GC002 to the Guadalupe River antenna is shown in Figure 13. Fish #9222 was detected multiple times from January to March 2021 This fish was YOY size (FL = 104) according to Smith and Leicester (2016) and at the end of its second year according to Moyle (2002). Fish #9222 was tagged with a 12 mm PIT tag. This detection indicates that movement occurred from the upper watershed through the Guadalupe River.

Table 6. O. mykiss tag number and associated information of each fish detected at the Guadalupe River antenna during the 2020-2021 migration season.

Date Tagged	Date Last Detected	Tag ID	Creek	Tagging Station	Fork-length (mm)
10/9/2019	2/23/2021	900.22600031**9222**	Guadalupe Creek	GC002	104

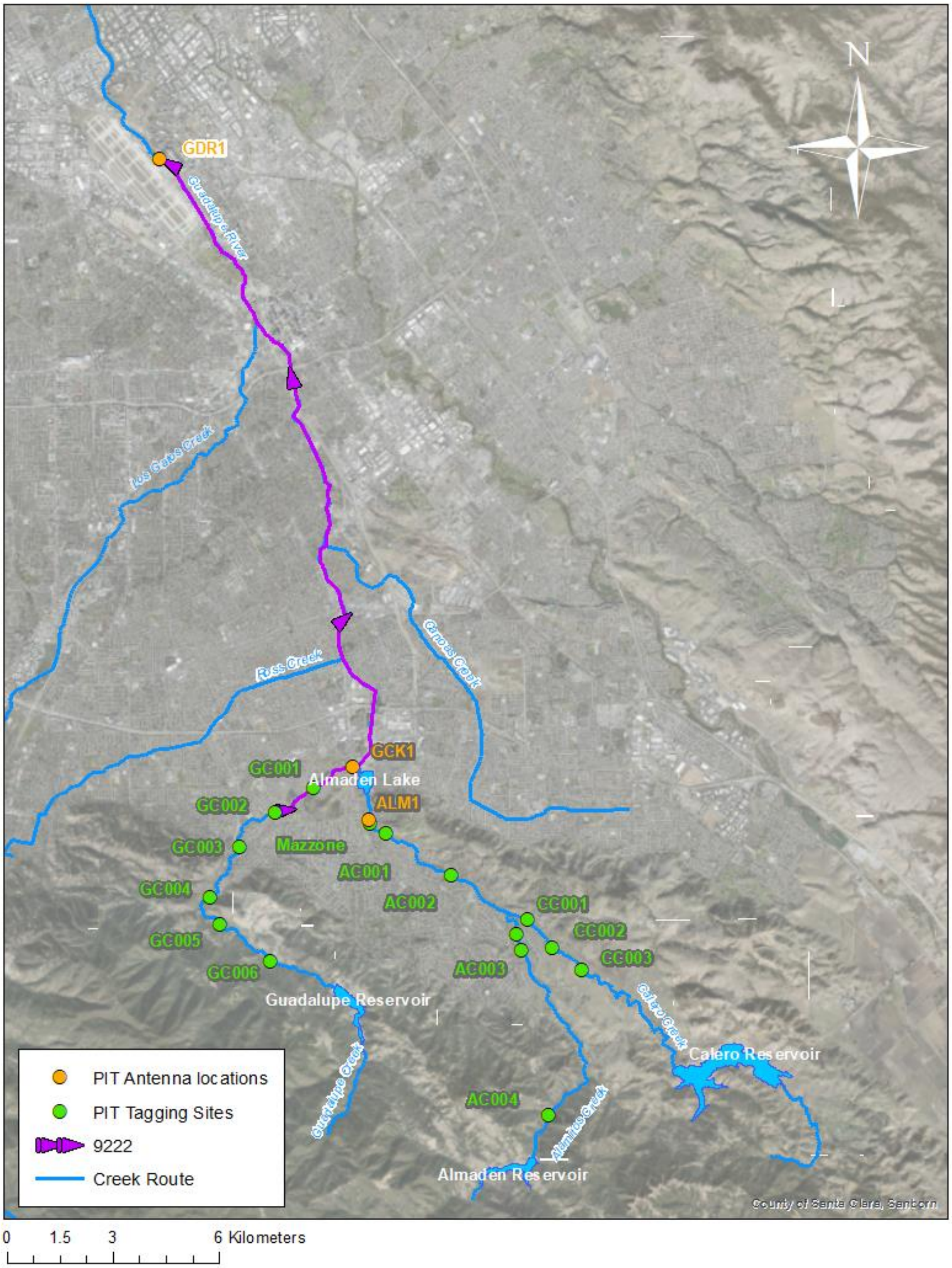

Figure 13. O. mykiss #9222 tagging location on Guadalupe Creek and relative path to the Guadalupe River antenna.

Fish #9222 was detected by the Guadalupe River antenna in late January about two months after the first storm of the season, which was small, and immediately before the largest storm of the season (Figure 14). Movement did not appear to be associated with the ascending or descending limb of the hydrograph. All movement was detected when flows were less than 50 cfs. Fish #9222 was not detected at any of the upstream antennas, and no fish detected at upstream antennas were detected on the Guadalupe River Antenna. Five outages occurred in 2021. The first outage in January was early in the outmigration period for juvenile steelhead and when flows were relatively low. The other outages were between late January and mid-March, and some occurred during or close to a storm event. These outages could have resulted in missed detections at this antenna.

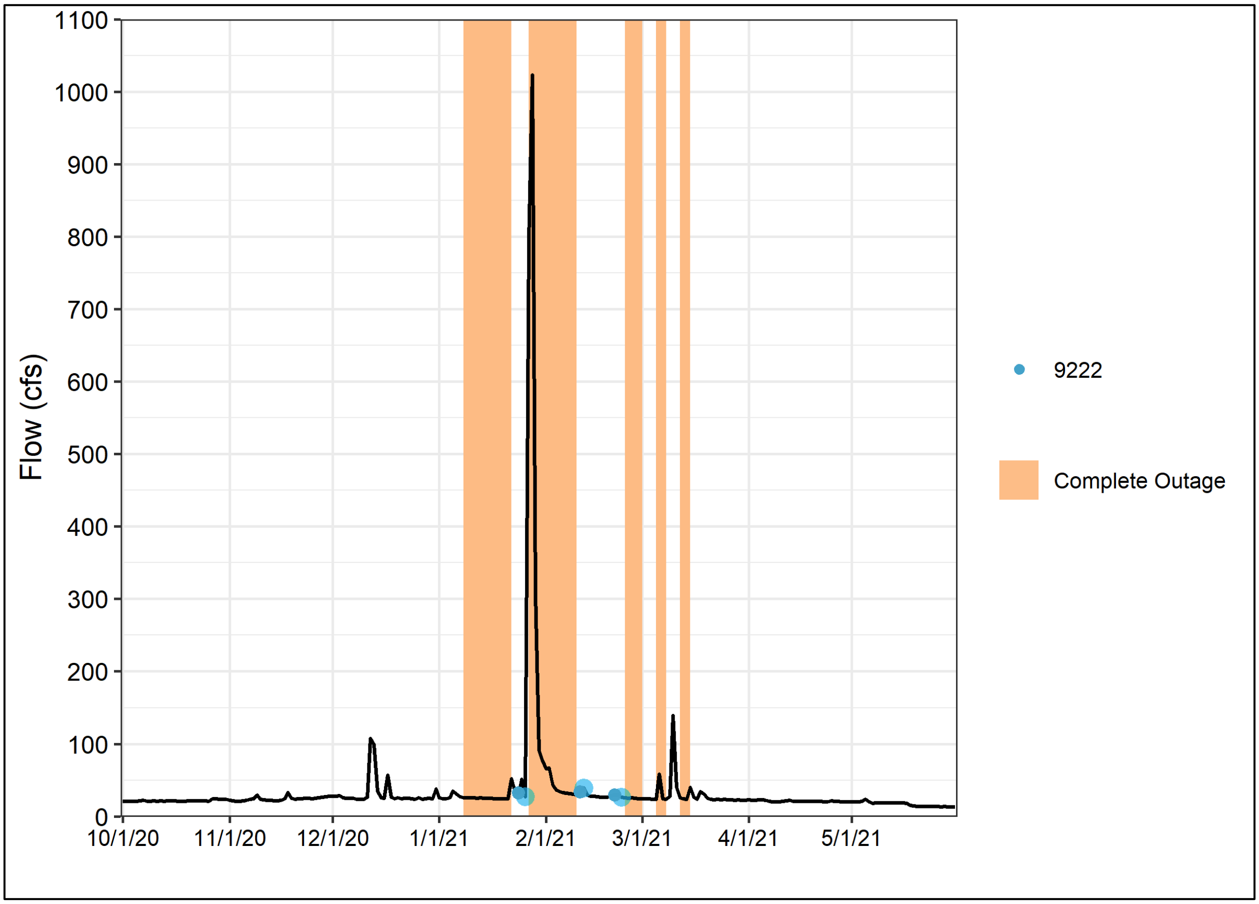

Figure 14. O. mykiss tracked on the Guadalupe River antenna compared to average daily flow on Guadalupe River at USGS Stream Gage (11169025) and antenna outages. Transparency was added to the points to better decipher movement of the single individual detected on the antenna. Numbers in legend indicate the last four digits of O. mykiss PIT tag numbers.

Conclusion

The 2020/2021 migration season was an extremely low flow year and migration opportunities were limited. According to the National Oceanic and Atmospheric Administration’s (NOAA’s) National Integrated Drought Information System (NIDIS), WY 2021 was characterized as “abnormally dry” throughout Santa Clara County. From October to November 2020, 95-96% of the county was in moderate drought, increasing to 100% of the county from early December 2020 to late January 2021. From late November to early January, approximately 48% of the county was in severe drought, increasing to 68% of the county for the remainder of January. From early February to late March 2021, 85-86% of the county was in moderate drought, increasing to 100% of the county in April. In late April 100% of the county was in severe drought, which increased to extreme drought throughout May 2021. Despite the limited passage opportunities, *O. mykiss* showing migratory tendencies were recorded from January to April, though *O. mykiss* were detected as early as December. Detections in December on Alamitos Creek were likely a result of the location of the antenna in proximity of the tagging location. No information regarding migration can be gleaned from these detections. *O. mykiss* from Guadalupe Creek, Calero Creek and Alamitos Creek appeared to contribute to outmigration in WY 2021. A complete picture of migrations cannot be drawn based on these results as no repeat detections occurred from upper watershed antennas and the downstream Guadalupe Antenna. Limitations of the PIT technology, environmental conditions, and low sample size of tagged fish and antenna stations all reduces the likelihood of repeat detections.

Of the *O. mykiss* detected, it is estimated that the *O. mykiss* showing migratory tendencies were potentially at the end of their first, second, and third year. In a status review of West Coast steelhead, Busby et al. (1996) analyzed scale and otolith data from adult *O. mykiss* and found that the modal smolt age for *O. mykiss* in Washington, Oregon, and California was typically two years old. However, the most southern portion of the *O. mykiss* range had an increase in frequency of 1-year-old *O. mykiss* smolts compared with the northern portion. Based on this data, the *O. mykiss* tracked by the PIT arrays in the Guadalupe River Watershed appear to fall in line with what is typically expected of this population and potentially multiple ages classes are contributing to outmigration. The antenna also picked up non-migratory, resident *O. mykiss* behavior, which provided insight into the use of habitat restored through gravel and large wood augmentation. Because this is only the third season of PIT tag monitoring in the Guadalupe River Watershed, results are limited, but a more robust dataset will develop as *O. mykiss* PIT tagging continues in the watershed over the coming years.

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Santa Clara Valley Water District (Valley Water). 2020b. Guadalupe River Watershed *Oncorhynchus mykiss* Migration Monitoring Using Passive Integrated Transponder Tags: Pilot Study.

Santa Clara Valley Water District (Valley Water). 2019. 2018 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Guadalupe River Watershed.

Smith and Leicester (2016) Guadalupe Creek Fish Sampling in October 2015 and 2016. California Department of Fish and Wildlife and San Jose State University.

Appendix A

PIT Tag Master List

Date	Creek	Species	Weight (g)	Length (mm)	PIT ID (Decimal)
12/16/2013	Guadalupe River	O. mykiss	-	134	982.000361656209
12/16/2013	Guadalupe River	O. mykiss	-	136	982.000361656215
12/16/2013	Guadalupe River	O. mykiss	-	155	982.000361656218
12/16/2013	Guadalupe River	O. mykiss	-	142	982.000361656222
12/16/2013	Guadalupe River	O. mykiss	-	-	982.000361656226
12/16/2013	Guadalupe River	O. mykiss	-	129	982.000361656230
12/16/2013	Guadalupe River	O. mykiss	-	133	982.000361656235
12/16/2013	Guadalupe River	O. mykiss	-	163	982.000361656237
12/16/2013	Guadalupe River	O. mykiss	-	125	982.000361656243
12/16/2013	Guadalupe River	O. mykiss	-	172	982.000361656249
12/16/2013	Guadalupe River	O. mykiss	-	151	982.000361656258
12/16/2013	Guadalupe River	O. mykiss	-	110	982.000362992258
12/16/2013	Guadalupe River	O. mykiss	-	160	982.000361656260
12/16/2013	Guadalupe River	O. mykiss	-	129	982.000361656263
12/16/2013	Guadalupe River	O. mykiss	-	230	982.000361656267
12/16/2013	Guadalupe River	O. mykiss	-	118	982.000362992269
12/16/2013	Guadalupe River	O. mykiss	-	175	982.000361656269
12/16/2013	Guadalupe River	O. mykiss	-	144	982.000361656274
12/16/2013	Guadalupe River	O. mykiss	-	122	982.000361656277
12/16/2013	Guadalupe River	O. mykiss	-	142	982.000361656278
12/16/2013	Guadalupe River	O. mykiss	-	112	982.000362992279
12/16/2013	Guadalupe River	O. mykiss	-	149	982.000361656280
12/16/2013	Guadalupe River	O. mykiss	-	135	982.000361656294
12/16/2013	Guadalupe River	O. mykiss	-	106	982.000362992296
12/16/2013	Guadalupe River	O. mykiss	-	122	982.000362992356
1/17/2014	Guadalupe River	O. mykiss	-	135	982.000361656216
1/17/2014	Los Gatos Creek	O. mykiss	-	115	982.000361656217
1/17/2014	Los Gatos Creek	O. mykiss	-	164	982.000361656229
1/17/2014	Guadalupe River	O. mykiss	-	156	982.000361656238
1/17/2014	Guadalupe River	O. mykiss	-	133	982.000361656247
1/17/2014	Guadalupe River	O. mykiss	-	120	982.000361656250
1/17/2014	Guadalupe River	O. mykiss	-	115	982.000361656252
1/17/2014	Guadalupe Creek	O. mykiss	-	80	982.000362992263
1/17/2014	Guadalupe River	O. mykiss	-	190	982.000361656264
1/17/2014	Guadalupe River	O. mykiss	-	150	982.000361656265
1/17/2014	Guadalupe Creek	O. mykiss	-	104	982.000362992272
1/17/2014	Guadalupe Creek	O. mykiss	-	85	982.000362992278
1/17/2014	Los Gatos Creek	O. mykiss	-	142	982.000361656288
1/17/2014	Guadalupe Creek	O. mykiss	-	93	982.000362992289
1/17/2014	Guadalupe Creek	O. mykiss	-	79	982.000362992290
1/17/2014	Guadalupe River	O. mykiss	-	119	982.000361656290
1/17/2014	Los Gatos Creek	O. mykiss	-	126	982.000361656298
1/17/2014	Los Gatos Creek	O. mykiss	-	89	982.000362992298
1/17/2014	Los Gatos Creek	O. mykiss	-	138	982.000361656299
1/17/2014	Guadalupe Creek	O. mykiss	-	75	982.000362992302
1/17/2014	Guadalupe Creek	O. mykiss	-	110	982.000362992303
1/17/2014	Guadalupe Creek	O. mykiss	-	155	982.000361656305

1/17/2014	Guadalupe Creek	O. mykiss	-	91	982.000362992306
1/17/2014	Guadalupe Creek	O. mykiss	-	91	982.000362992312
1/17/2014	Guadalupe Creek	O. mykiss	-	92	982.000362992315
1/17/2014	Guadalupe Creek	O. mykiss	-	71	982.000362992325
1/17/2014	Guadalupe Creek	O. mykiss	-	102	982.000362992327
1/17/2014	Guadalupe Creek	O. mykiss	-	79	982.000362992328
1/17/2014	Guadalupe Creek	O. mykiss	-	80	982.000362992330
1/17/2014	Guadalupe Creek	O. mykiss	-	110	982.000362992333
1/17/2014	Guadalupe Creek	O. mykiss	-	69	982.000362992340
1/17/2014	Guadalupe River	O. mykiss	-	138	982.000361656521
2/12/2014	Guadalupe River	O. mykiss	-	148	982.000361656219
2/12/2014	Guadalupe River	O. mykiss	-	189	982.000361656225
2/12/2014	Guadalupe River	O. mykiss	-	149	982.000361656227
2/12/2014	Guadalupe River	O. mykiss	-	179	982.000361656231
2/12/2014	Guadalupe River	O. mykiss	-	147	982.000361656242
2/12/2014	Guadalupe River	O. mykiss	-	156	982.000361656244
2/12/2014	Guadalupe River	O. mykiss	-	132	982.000361656272
2/12/2014	Guadalupe River	O. mykiss	-	193	982.000361656291
2/21/2014	Los Gatos Creek	O. mykiss	-	116	982.000361656213
2/21/2014	Los Gatos Creek	O. mykiss	-	142	982.000361656270
2/21/2014	Guadalupe River	O. mykiss	-	145	982.000361656311
2/21/2014	Los Gatos Creek	O. mykiss	-	112	982.000361656454
3/14/2014	Guadalupe River	O. mykiss	-	153	982.000361654515
3/15/2014	Pond A8	striped bass		520	982.000362654458
3/15/2014	Pond A8	striped bass		500	982.000362654476
3/15/2014	Pond A8	striped bass		530	982.000362655000
3/15/2014	Pond A8	striped bass		500	982.000362654505
3/15/2014	Pond A8	striped bass		440	982.000362654514
3/15/2014	Pond A8	striped bass		470	982.000362654539
4/17/2014	Pond A5	Leopard Shark	-	1219	982.000362654450
4/17/2014	Pond A5	Leopard Shark	-	838	982.000362654453
4/17/2014	Pond A5	Leopard Shark	-	864	982.000362654461
4/17/2014	Pond A5	Leopard Shark	-	914	982.000362654494
4/17/2014	Pond A5	Leopard Shark	-	864	982.000362654521
4/17/2014	Pond A5	Leopard Shark	-	889	982.000362654528
4/17/2014	Pond A8	striped bass		737	982.000362654448
4/17/2014	Pond A8	striped bass		762	982.000362654460
4/17/2014	Pond A8	striped bass		660	982.000362654466
4/17/2014	Pond A8	striped bass		787	982.000362654467
4/17/2014	Pond A8	striped bass		330	982.000362655150
4/17/2014	Pond A8	striped bass		762	982.000362654524
4/17/2014	Pond A8	striped bass		965	982.000362654529
4/17/2014	Pond A8	striped bass		305	982.000362654534
4/17/2014	Pond A8	striped bass		305	982.000362654537
4/17/2014	Pond A8	striped bass		838	982.000362654540
4/17/2014	Pond A8	striped bass		508	982.000362654543
10/19/2014	Alamitos Creek	O. mykiss		105	982.000362992262
10/19/2014	Alamitos Creek	O. mykiss		98	982.0003629923

10/19/2014	Guadalupe Creek	O. mykiss		110	982.000362992288
10/19/2014	Guadalupe Creek	O. mykiss		110	982.000362992271
10/19/2014	Guadalupe Creek	O. mykiss		65	982.000362992351
10/19/2014	Guadalupe Creek	O. mykiss		110	982.000362992281
10/19/2014	Guadalupe Creek	O. mykiss		90	982.000362992331
10/19/2014	Guadalupe Creek	O. mykiss		81	982.000362992285
11/2/2014	Guadalupe Creek	O. mykiss		146	982.000362655573
11/2/2014	Guadalupe Creek	O. mykiss		100	982.000362992305
11/2/2014	Guadalupe Creek	O. mykiss		117	982.000362992280
11/2/2014	Guadalupe Creek	O. mykiss		173	982.000362654463
11/2/2014	Guadalupe Creek	O. mykiss		124	982.000362654546
11/2/2014	Guadalupe Creek	O. mykiss		86	982.000362992307
11/2/2014	Guadalupe Creek	O. mykiss		67	982.000362992342
11/2/2014	Guadalupe Creek	O. mykiss		96	982.000362654480
11/3/2014	Guadalupe Creek	O. mykiss		NA	982.000360826977
11/3/2014	Guadalupe Creek	O. mykiss		93	982.000362992308
11/3/2014	Guadalupe Creek	O. mykiss		85	982.000360826958
11/3/2014	Guadalupe Creek	O. mykiss		72	982.000362992287
11/3/2014	Guadalupe Creek	O. mykiss		123	982.000362655643
11/3/2014	Guadalupe Creek	O. mykiss		120	982.000362655612
11/3/2014	Guadalupe Creek	O. mykiss		78	982.000362992353
11/3/2014	Guadalupe Creek	O. mykiss		139	982.000362655554
11/3/2014	Guadalupe Creek	O. mykiss		168	982.000362655626
11/3/2014	Guadalupe Creek	O. mykiss		72	982.000362992295
11/3/2014	Guadalupe Creek	O. mykiss		65	982.000362992317
11/3/2014	Guadalupe Creek	O. mykiss		88	982.000362992310
9/17/2018	Alamitos Creek	O. mykiss	43.06	146	900.226000319370
9/17/2018	Alamitos Creek	O. mykiss	15.14	111	900.226000319353
9/17/2018	Alamitos Creek	O. mykiss	-	199	900.226000319320
9/17/2018	Alamitos Creek	O. mykiss	17.2	109	900.226000319322
9/17/2018	Alamitos Creek	O. mykiss	13.3	102	900.226000319339
9/17/2018	Alamitos Creek	O. mykiss	15.09	107	900.226000319313
9/17/2018	Alamitos Creek	O. mykiss	8.33	89	900.226000319367
9/17/2018	Alamitos Creek	O. mykiss	-	248	900.226000319355
9/17/2018	Alamitos Creek	O. mykiss	12.92	103	900.226000319350
9/17/2018	Alamitos Creek	O. mykiss	21.42	119	900.226000319366
9/17/2018	Alamitos Creek	O. mykiss	19.34	117	900.226000319375
9/17/2018	Alamitos Creek	O. mykiss	16.51	111	900.226000319326
9/17/2018	Alamitos Creek	O. mykiss	23.78	122	900.226000319387
9/17/2018	Alamitos Creek	O. mykiss	26.74	132	900.226000319376
9/17/2018	Alamitos Creek	O. mykiss	30.42	141	900.226000319319
9/17/2018	Alamitos Creek	O. mykiss	32.1	136	900.226000319352
9/17/2018	Alamitos Creek	O. mykiss	13.3	103	900.226000319314
9/17/2018	Alamitos Creek	O. mykiss	32.7	138	900.226000319391
9/17/2018	Alamitos Creek	O. mykiss	25.26	129	900.226000319310
9/17/2018	Alamitos Creek	O. mykiss	11.5	97	900.226000319372
9/17/2018	Alamitos Creek	O. mykiss	81.27	186	900.226000319301
9/17/2018	Alamitos Creek	O. mykiss	19.01	117	900.226000319384

9/17/2018	Alamitos Creek	O. mykiss	14.39	104	900.226000319316
9/17/2018	Alamitos Creek	O. mykiss	11.97	102	900.226000319397
9/17/2018	Alamitos Creek	O. mykiss	10	95	900.226000319388
9/17/2018	Alamitos Creek	O. mykiss	14.48	106	900.226000319360
9/17/2018	Alamitos Creek	O. mykiss	18.58	115	900.226000319321
9/17/2018	Alamitos Creek	O. mykiss	23.03	122	900.226000319348
10/16/2018	Guadalupe Creek	O. mykiss	7.81	83	900.226000319227
10/16/2018	Guadalupe Creek	O. mykiss	9.25	87	900.226000319276
10/16/2018	Guadalupe Creek	O. mykiss	14.28	106	900.226000319293
10/16/2018	Guadalupe Creek	O. mykiss	4.75	67	900.226000319318
10/16/2018	Guadalupe Creek	O. mykiss	4.62	72	900.226000319305
10/16/2018	Guadalupe Creek	O. mykiss	3.72	66	900.226000319334
10/16/2018	Guadalupe Creek	O. mykiss	6.37	72	900.226000319341
10/16/2018	Guadalupe Creek	O. mykiss	3.58	65	900.226000319308
10/16/2018	Guadalupe Creek	O. mykiss	31.33	138	900.226000319389
10/16/2018	Guadalupe Creek	O. mykiss	6.82	81	900.226000319385
10/16/2018	Guadalupe Creek	O. mykiss	4.58	66	900.226000319338
10/16/2018	Guadalupe Creek	O. mykiss	5.32	74	900.226000319324
10/16/2018	Guadalupe Creek	O. mykiss	6.93	86	900.226000319364
10/16/2018	Guadalupe Creek	O. mykiss	6.66	79	900.226000319345
10/16/2018	Guadalupe Creek	O. mykiss	8.33	84	900.226000319358
10/16/2018	Guadalupe Creek	O. mykiss	6.12	76	900.226000319329
10/16/2018	Guadalupe Creek	O. mykiss	4.97	70	900.226000319351
10/17/2018	Guadalupe Creek	O. mykiss	5.62	75	900.226000319346
10/17/2018	Guadalupe Creek	O. mykiss	4.22	66	900.226000319394
10/17/2018	Guadalupe Creek	O. mykiss	6.02	79	900.226000319386
10/17/2018	Guadalupe Creek	O. mykiss	5.9	77	900.226000319340
10/17/2018	Guadalupe Creek	O. mykiss	4.52	70	900.226000319317
10/17/2018	Guadalupe Creek	O. mykiss	5.14	72	900.226000319337
10/17/2018	Guadalupe Creek	O. mykiss	8.05	86	900.226000319344
10/17/2018	Guadalupe Creek	O. mykiss	4.23	68	900.226000319330
10/17/2018	Guadalupe Creek	O. mykiss	6.06	75	900.226000319307
10/17/2018	Guadalupe Creek	O. mykiss	4.08	67	900.226000319309
10/17/2018	Guadalupe Creek	O. mykiss	3.83	65	900.226000319333
10/17/2018	Guadalupe Creek	O. mykiss	5.66	74	900.226000319361
10/17/2018	Guadalupe Creek	O. mykiss	96.04	199	900.228000613702
10/17/2018	Guadalupe Creek	O. mykiss	4.61	65	900.226000319381
10/17/2018	Guadalupe Creek	O. mykiss	6.62	76	900.226000319342
10/17/2018	Guadalupe Creek	O. mykiss	4.35	66	900.226000319399
10/17/2018	Guadalupe Creek	O. mykiss	4.63	70	900.226000319377
10/17/2018	Guadalupe Creek	O. mykiss	5.68	72	900.226000319371
10/17/2018	Guadalupe Creek	O. mykiss	6.23	75	900.226000319395
10/17/2018	Guadalupe Creek	O. mykiss	4.95	69	900.226000319325
10/17/2018	Guadalupe Creek	O. mykiss	6.2	78	900.226000319356
10/17/2018	Guadalupe Creek	O. mykiss	6.22	79	900.226000319374
10/17/2018	Guadalupe Creek	O. mykiss	4.36	69	900.226000319379
10/17/2018	Guadalupe Creek	O. mykiss	4.53	67	900.226000319354
10/17/2018	Guadalupe Creek	O. mykiss	18.15	112	900.226000319328

10/17/2018	Guadalupe Creek	O. mykiss	3.85	68	900.226000319393
10/17/2018	Guadalupe Creek	O. mykiss	5.05	79	900.226000319327
10/17/2018	Guadalupe Creek	O. mykiss	5.23	74	900.226000319362
10/17/2018	Guadalupe Creek	O. mykiss	11.22	90	900.226000319304
10/17/2018	Guadalupe Creek	O. mykiss	5.31	74	900.226000319398
10/18/2018	Alamitos Creek	O. mykiss	5.35	68	900.226000319284
10/18/2018	Alamitos Creek	O. mykiss	4.23	66	900.226000319260
10/18/2018	Alamitos Creek	O. mykiss	4.35	65	900.226000319291
10/18/2018	Alamitos Creek	O. mykiss	3.25	65	900.226000319292
10/18/2018	Alamitos Creek	O. mykiss	4.86	69	900.226000319295
10/18/2018	Alamitos Creek	O. mykiss	20.6	125	900.226000319250
10/18/2018	Alamitos Creek	O. mykiss	17.5	109	900.226000319246
10/18/2018	Alamitos Creek	O. mykiss	36.5	145	900.226000319258
10/18/2018	Alamitos Creek	O. mykiss	14.8	79	900.226000319263
10/18/2018	Alamitos Creek	O. mykiss	24.9	109	900.226000319201
10/18/2018	Alamitos Creek	O. mykiss	12.5	94	900.226000319218
10/18/2018	Alamitos Creek	O. mykiss	18.6	106	900.226000319269
10/18/2018	Alamitos Creek	O. mykiss	20.2	111	900.226000319200
10/18/2018	Alamitos Creek	O. mykiss	19	108	900.226000319311
10/18/2018	Alamitos Creek	O. mykiss	42.3	146	900.226000319257
10/18/2018	Alamitos Creek	O. mykiss	16.8	110	900.226000319290
10/22/2018	Alamitos Creek	O. mykiss	7.7	84	900.226000319343
10/22/2018	Alamitos Creek	O. mykiss	13.8	98	900.226000319306
10/22/2018	Alamitos Creek	O. mykiss	13	100	900.226000319349
10/22/2018	Alamitos Creek	O. mykiss	9.6	91	900.226000319312
10/22/2018	Alamitos Creek	O. mykiss	14.1	102	900.226000319315
10/22/2018	Alamitos Creek	O. mykiss	12.8	103	900.226000319382
10/22/2018	Alamitos Creek	O. mykiss	10	91	900.226000319365
10/22/2018	Alamitos Creek	O. mykiss	445	345	900.228000613703
10/22/2018	Alamitos Creek	O. mykiss	9.4	92	900.226000319363
10/22/2018	Alamitos Creek	O. mykiss	10.2	90	900.226000319390
10/22/2018	Alamitos Creek	O. mykiss	23	119	900.226000319378
10/22/2018	Alamitos Creek	O. mykiss	25.1	115	900.226000319396
10/22/2018	Alamitos Creek	O. mykiss	20.8	117	900.226000319368
10/22/2018	Alamitos Creek	O. mykiss	28.2	129	900.226000319380
10/23/2018	Calero Creek	O. mykiss	215.3	263	900.228000613704
10/23/2018	Calero Creek	O. mykiss	7.5	82	900.226000319280
10/23/2018	Calero Creek	O. mykiss	125.2	216	900.228000613705
10/23/2018	Calero Creek	O. mykiss	14.3	109	900.226000319268
10/23/2018	Calero Creek	O. mykiss	11.5	95	900.226000319336
10/23/2018	Calero Creek	O. mykiss	7.3	82	900.226000319302
10/23/2018	Calero Creek	O. mykiss	10.1	89	900.226000319332
10/23/2018	Calero Creek	O. mykiss	5.2	67	900.226000319373
10/24/2018	Calero Creek	O. mykiss	9.3	84	900.226000319357
10/24/2018	Calero Creek	O. mykiss	7.8	84	900.226000319347
10/24/2018	Calero Creek	O. mykiss	5.4	75	900.226000319323
10/24/2018	Calero Creek	O. mykiss	10.4	86	900.226000319300
10/24/2018	Calero Creek	O. mykiss	8.5	85	900.226000319231

10/24/2018	Calero Creek	O. mykiss	12.5	94	900.226000319244
10/24/2018	Calero Creek	O. mykiss	8.3	82	900.226000319287
10/24/2018	Calero Creek	O. mykiss	10.2	93	900.226000319230
10/24/2018	Calero Creek	O. mykiss	9.4	86	900.226000319212
11/6/2018	Guadalupe Creek	O. mykiss	12.4	95	900.226000319294
11/6/2018	Guadalupe Creek	O. mykiss	8.7	87	900.226000319214
11/6/2018	Guadalupe Creek	O. mykiss	18.2	116	900.226000319278
10/9/2019	Guadalupe Creek	O. mykiss	5.73	75	900.228000613710
10/9/2019	Guadalupe Creek	O. mykiss	6.6	84	900.226000319233
10/9/2019	Guadalupe Creek	O. mykiss	9.5	88	900.226000319239
10/9/2019	Guadalupe Creek	O. mykiss	7.1	81	900.226000319210
10/9/2019	Guadalupe Creek	O. mykiss	152.1	234	900.228000613711
10/9/2019	Guadalupe Creek	O. mykiss	5.1	71	900.226000319209
10/9/2019	Guadalupe Creek	O. mykiss	5.8	77	900.226000319277
10/9/2019	Guadalupe Creek	O. mykiss	9.6	85	900.226000319220
10/9/2019	Guadalupe Creek	O. mykiss	53.6	168	900.228000613712
10/9/2019	Guadalupe Creek	O. mykiss	14.7	104	900.226000319222
10/9/2019	Guadalupe Creek	O. mykiss	8.6	84	900.226000319228
10/9/2019	Guadalupe Creek	O. mykiss	8.0	76	900.226000319237
10/10/2019	Alamitos Creek	O. mykiss	11.4	95	900.226000319265
10/10/2019	Guadalupe Creek	O. mykiss	8.6	82	900.226000319288
10/10/2019	Guadalupe Creek	O. mykiss	8.6	86	900.226000319208
10/10/2019	Guadalupe Creek	O. mykiss	9.4	89	900.226000319252
10/10/2019	Guadalupe Creek	O. mykiss	3.4	66	900.226000319369
10/10/2019	Guadalupe Creek	O. mykiss	7.9	85	900.226000319249
10/10/2019	Guadalupe Creek	O. mykiss	41.7	150	900.226000319215
10/10/2019	Guadalupe Creek	O. mykiss	16.3	106	900.226000319204
10/10/2019	Guadalupe Creek	O. mykiss	6.5	82	900.226000319296
10/10/2019	Guadalupe Creek	O. mykiss	14.3	99	900.226000319261
10/10/2019	Guadalupe Creek	O. mykiss	7.1	81	900.226000319206
10/10/2019	Guadalupe Creek	O. mykiss	10.2	91	900.226000319242
10/10/2019	Guadalupe Creek	O. mykiss	7.7	81	900.226000319219
10/10/2019	Guadalupe Creek	O. mykiss	9.5	89	900.226000319216
10/10/2019	Guadalupe Creek	O. mykiss	10.4	91	900.226000319281
10/10/2019	Guadalupe Creek	O. mykiss	12.3	100	900.226000319217
10/10/2019	Guadalupe Creek	O. mykiss	16.5	107	900.226000319272
10/10/2019	Guadalupe Creek	O. mykiss	13.4	104	900.226000319247
10/23/2019	Alamitos Creek	O. mykiss	7.9	83	900.226000319254
10/23/2019	Alamitos Creek	O. mykiss	11.5	87	900.226000319203
10/23/2019	Alamitos Creek	O. mykiss	5.5	75	900.226000319205
10/23/2019	Alamitos Creek	O. mykiss	3.3	65	900.226000319225
10/23/2019	Alamitos Creek	O. mykiss	3.9	68	900.226000319282
10/23/2019	Alamitos Creek	O. mykiss	4.9	71	900.226000319224
10/23/2019	Alamitos Creek	O. mykiss	5.7	76	900.226000319248
10/23/2019	Alamitos Creek	O. mykiss	13.9	105	900.226000319221
10/23/2019	Alamitos Creek	O. mykiss	5.3	72	900.226000319226
10/23/2019	Alamitos Creek	O. mykiss	4.1	68	900.226000319202
10/23/2019	Alamitos Creek	O. mykiss	4.8	69	900.226000319223

10/23/2019	Alamitos Creek	O. mykiss	14.4	105	900.226000319236
10/23/2019	Alamitos Creek	O. mykiss	4.7	67	900.226000319240
10/23/2019	Alamitos Creek	O. mykiss	22.9	122	900.226000319274
10/23/2019	Alamitos Creek	O. mykiss	5.2	73	900.226000319283
10/23/2019	Alamitos Creek	O. mykiss	10.7	90	900.226000319273
10/23/2019	Alamitos Creek	O. mykiss	15.1	106	900.226000319256
10/23/2019	Alamitos Creek	O. mykiss	9.0	88	900.226000319211
10/28/2019	Calero Creek	O. mykiss	250.1	280	900.228000613713
10/28/2019	Calero Creek	O. mykiss	7.9	85	900.226000319259
10/28/2019	Calero Creek	O. mykiss	6.6	81	900.226000319297
10/28/2019	Calero Creek	O. mykiss	12.4	96	900.226000319285
10/28/2019	Calero Creek	O. mykiss	14.6	107	900.226000319286
10/28/2019	Calero Creek	O. mykiss	12.3	95	900.226000319207
10/28/2019	Calero Creek	O. mykiss	8.5	86	900.226000319245
10/30/2019	Guadalupe River	O. mykiss	169.6	248	900.228000613714
10/31/2019	Alamitos Creek	O. mykiss	7.0	81	900.226000319270
10/31/2019	Alamitos Creek	O. mykiss	12.2	99	900.226000319232
10/31/2019	Alamitos Creek	O. mykiss	28.8	134	900.226000319213
10/31/2019	Alamitos Creek	O. mykiss	11.7	95	900.226000319241
10/31/2019	Alamitos Creek	O. mykiss	5.8	75	900.226000319267
10/31/2019	Alamitos Creek	O. mykiss	10.7	90	900.226000319298
10/31/2019	Alamitos Creek	O. mykiss	6.3	76	900.226000319299
10/31/2019	Alamitos Creek	O. mykiss	13.4	98	900.226000319234
10/31/2019	Alamitos Creek	O. mykiss	11.6	93	900.226000319271
10/31/2019	Alamitos Creek	O. mykiss	11.5	95	900.226000319238
10/31/2019	Alamitos Creek	O. mykiss	11.9	99	900.226000319255
10/31/2019	Alamitos Creek	O. mykiss	8.5	90	900.226000319251
10/31/2019	Alamitos Creek	O. mykiss	15.9	103	900.226000319262
10/31/2019	Alamitos Creek	O. mykiss	25.4	130	900.226000319253
10/31/2019	Alamitos Creek	O. mykiss	12.0	96	900.226000319229
10/31/2019	Alamitos Creek	O. mykiss	14.1	97	900.226000319275
10/31/2019	Alamitos Creek	O. mykiss	20.2	115	900.226000319279
10/31/2019	Alamitos Creek	O. mykiss	33.6	140	982.126058146080
10/31/2019	Alamitos Creek	O. mykiss	18.9	112	982.126058146069
10/31/2019	Alamitos Creek	O. mykiss	19.5	117	982.126058146081
10/31/2019	Alamitos Creek	O. mykiss	15.1	105	982.126058146089
10/31/2019	Alamitos Creek	O. mykiss	6.6	80	982.126058146053
10/31/2019	Alamitos Creek	O. mykiss	65.4	173	900.228000613716
10/31/2019	Alamitos Creek	O. mykiss	281.8	280	900.228000613715
10/31/2019	Alamitos Creek	O. mykiss	60.3	170	900.228000613718
10/31/2019	Alamitos Creek	O. mykiss	40.1	150	900.228000613717
11/4/2019	Upper Penitencia	O. mykiss	5.2	74	982.126058146054
11/4/2019	Upper Penitencia	O. mykiss	6.0	76	982.126058146126
11/4/2019	Upper Penitencia	O. mykiss	7.0	79	982.126058146101
11/4/2019	Upper Penitencia	O. mykiss	9.3	89	982.126058146077
11/4/2019	Upper Penitencia	O. mykiss	75.1	189	900.228000613719
11/4/2019	Upper Penitencia	O. mykiss	17.8	111	982.126058146117
11/4/2019	Upper Penitencia	O. mykiss	15.1	108	982.126058146065

11/4/2019	Upper Penitencia	O. mykiss	9.9	94	982.126058146106
11/4/2019	Upper Penitencia	O. mykiss	9.1	88	982.126058146036
11/4/2019	Upper Penitencia	O. mykiss	96.5	209	900.228000613720
11/4/2019	Upper Penitencia	O. mykiss	151.3	236	900.228000613721
11/4/2019	Upper Penitencia	O. mykiss	-	-	900.228000613722
11/4/2019	Upper Penitencia	O. mykiss	12.4	97	982.126058146093
11/4/2019	Upper Penitencia	O. mykiss	7.8	85	982.126058146039
11/4/2019	Upper Penitencia	O. mykiss	11.3	93	982.126058146070
11/4/2019	Upper Penitencia	O. mykiss	63.9	177	900.228000613723
11/4/2019	Upper Penitencia	O. mykiss	5.1	74	982.126058146083
11/4/2019	Upper Penitencia	O. mykiss	59.4	178	900.228000613724
11/4/2019	Upper Penitencia	O. mykiss	13.8	105	982.126058146067
11/4/2019	Upper Penitencia	O. mykiss	8.5	84	982.126058146084
11/4/2019	Upper Penitencia	O. mykiss	-	79	982.126058146042
11/4/2019	Upper Penitencia	O. mykiss	24.1	130	982.126058146043
11/4/2019	Upper Penitencia	O. mykiss	-	106	982.126058146105
11/4/2019	Upper Penitencia	O. mykiss	12	92	982.126058146111
11/4/2019	Upper Penitencia	O. mykiss	4.5	73	982.126058146044
11/4/2019	Upper Penitencia	O. mykiss	7.6	84	982.126058146100
11/4/2019	Upper Penitencia	O. mykiss	17.3	108	982.126058146116
11/4/2019	Upper Penitencia	O. mykiss	48.2	162	900.228000613726
11/4/2019	Upper Penitencia	O. mykiss	10.8	92	982.126058146058
11/4/2019	Upper Penitencia	O. mykiss	41.1	158	900.228000613727
11/4/2019	Upper Penitencia	O. mykiss	8.7	91	982.126058146085
11/4/2019	Upper Penitencia	O. mykiss	5.2	73	982.126058146095
11/4/2019	Upper Penitencia	O. mykiss	7.2	85	982.126058146103
11/4/2019	Upper Penitencia	O. mykiss	15.5	103	982.126058146046
11/4/2019	Upper Penitencia	O. mykiss	10.7	100	982.126058146074
11/4/2019	Upper Penitencia	O. mykiss	5.8	78	982.126058146076
11/4/2019	Upper Penitencia	O. mykiss	41.9	156	900.228000613728
11/4/2019	Upper Penitencia	O. mykiss	38.6	145	982.126058146034
11/4/2019	Upper Penitencia	O. mykiss	49.2	162	900.228000613730
11/4/2019	Upper Penitencia	O. mykiss	12.5	101	982.126058146096
11/4/2019	Upper Penitencia	O. mykiss	6.2	78	982.126058146055
11/4/2019	Upper Penitencia	O. mykiss	13.3	96	982.126058146033
11/4/2019	Upper Penitencia	O. mykiss	8.7	88	982.126058146037
11/4/2019	Upper Penitencia	O. mykiss	6.9	83	982.126058146063
11/4/2019	Upper Penitencia	O. mykiss	13.1	102	982.126058146071
11/4/2019	Upper Penitencia	O. mykiss	143.1	234	900.228000613729
11/4/2019	Upper Penitencia	O. mykiss	5.8	75	982.126058146129
11/4/2019	Upper Penitencia	O. mykiss	19.7	112	982.126058146064
11/4/2019	Upper Penitencia	O. mykiss	55.3	172	900.228000613731
11/4/2019	Upper Penitencia	O. mykiss	11.5	98	982.126058146079
11/4/2019	Upper Penitencia	O. mykiss	19.2	112	982.126058146068
11/4/2019	Upper Penitencia	O. mykiss	6.2	79	982.126058146092
11/4/2019	Upper Penitencia	O. mykiss	7.9	86	982.126058146056
11/4/2019	Upper Penitencia	O. mykiss	5.3	77	982.126058146087
11/4/2019	Upper Penitencia	O. mykiss	6.3	81	982.126058146048

11/4/2019	Upper Penitencia	O. mykiss	8.7	90	982.126058146062
11/4/2019	Upper Penitencia	O. mykiss	6.3	78	982.126058146041
11/4/2019	Upper Penitencia	O. mykiss	13.9	101	982.126058146098
11/4/2019	Upper Penitencia	O. mykiss	5.5	77	982.126058146113
11/4/2019	Upper Penitencia	O. mykiss	5.1	74	982.126058146115
11/4/2019	Upper Penitencia	O. mykiss	8.6	90	982.126058146088
11/4/2019	Upper Penitencia	O. mykiss	171.5	245	900.228000613732
11/6/2019	Coyote Creek	O. mykiss	18.1	112	982.126058146078
11/6/2019	Coyote Creek	O. mykiss	23.2	122	982.126058146114
11/6/2019	Coyote Creek	O. mykiss	28.2	133	982.126058146107
11/13/2019	Upper Penitencia	O. mykiss	31.8	141	982.126058146110
11/13/2019	Upper Penitencia	O. mykiss	10.6	95	982.126058146131
11/13/2019	Upper Penitencia	O. mykiss	38.8	153	900.228000613734
11/13/2019	Upper Penitencia	O. mykiss	24.8	128	982.126058146118
11/13/2019	Upper Penitencia	O. mykiss	20.4	125	982.126058146082
11/13/2019	Upper Penitencia	O. mykiss	58.2	172	900.228000613735
11/13/2019	Upper Penitencia	O. mykiss	54.7	168	900.228000613736
11/13/2019	Upper Penitencia	O. mykiss	35.2	149	982.126058146075
11/13/2019	Upper Penitencia	O. mykiss	147.8	238	900.228000613738
11/13/2019	Upper Penitencia	O. mykiss	46.3	159	900.228000613739
11/13/2019	Upper Penitencia	O. mykiss	23.5	124	982.126058146102
11/13/2019	Upper Penitencia	O. mykiss	96.5	204	900.228000613737
11/13/2019	Upper Penitencia	O. mykiss	68.9	184	900.228000613740
11/13/2019	Upper Penitencia	O. mykiss	119.5	224	900.228000613742
11/13/2019	Upper Penitencia	O. mykiss	7.5	84	982.126058146051
11/13/2019	Upper Penitencia	O. mykiss	7.5	86	982.126058146038
11/13/2019	Upper Penitencia	O. mykiss	30.5	140	982.126058146123
11/13/2019	Upper Penitencia	O. mykiss	9.8	88	982.126058146057
11/13/2019	Upper Penitencia	O. mykiss	12.2	97	982.126058146032
11/13/2019	Upper Penitencia	O. mykiss	8.7	80	982.126058146073
11/13/2019	Upper Penitencia	O. mykiss	23.6	125	982.126058146047
11/13/2019	Upper Penitencia	O. mykiss	15.7	94	982.126058146122
11/13/2019	Upper Penitencia	O. mykiss	13.8	94	982.126058146049
11/13/2019	Upper Penitencia	O. mykiss	9.1	86	982.126058146109
11/13/2019	Upper Penitencia	O. mykiss	8.8	84	982.126058146052
11/13/2019	Upper Penitencia	O. mykiss	24.5	124	982.126058146099
11/13/2019	Upper Penitencia	O. mykiss	26.3	128	982.126058146128
11/13/2019	Upper Penitencia	O. mykiss	73.5	184	900.228000613743
11/13/2019	Upper Penitencia	O. mykiss	38.5	134	982.126058146124
11/13/2019	Upper Penitencia	O. mykiss	2.9	84	982.126058146045
11/13/2019	Upper Penitencia	O. mykiss	110.3	209	900.228000613744
11/13/2019	Upper Penitencia	O. mykiss	28.9	132	982.126058146108
11/13/2019	Upper Penitencia	O. mykiss	12.4	96	982.126058146090
11/13/2019	Upper Penitencia	O. mykiss	37.2	154	982.126058146059
8/4/2020	Upper Penitencia Creek	O. mykiss	38.2	147	982.126058146943
8/4/2020	Upper Penitencia Creek	O. mykiss		144	982.126058146121
8/4/2020	Upper Penitencia Creek	O. mykiss	25.4	129	982.126058146947
8/4/2020	Upper Penitencia Creek	O. mykiss	22.2	121	982.126058146948

8/4/2020	Upper Penitencia Creek	O. mykiss	39.3	152	900.228000613803
8/4/2020	Upper Penitencia Creek	O. mykiss	59.1	178	900.228000613802
8/4/2020	Upper Penitencia Creek	O. mykiss	124	237	900.228000613804
8/4/2020	Upper Penitencia Creek	O. mykiss	31.5	142	982.126058146963
8/4/2020	Upper Penitencia Creek	O. mykiss	36.1	151	900.228000613801
8/4/2020	Upper Penitencia Creek	O. mykiss	79.4	196	900.228000613806
8/4/2020	Upper Penitencia Creek	O. mykiss		104	982.126058146086
8/4/2020	Upper Penitencia Creek	O. mykiss	26.4	130	982.126058146954
8/4/2020	Upper Penitencia Creek	O. mykiss		123	982.126058146066
10/21/2020	Guadalupe Creek	O. mykiss	3.9	67	982.126058146127
10/21/2020	Guadalupe Creek	O. mykiss	6.4	78	982.126058146094
10/21/2020	Guadalupe Creek	O. mykiss	4.1	71	982.126058146060
10/21/2020	Guadalupe Creek	O. mykiss	59.7	184	900.228000613747
10/21/2020	Guadalupe Creek	O. mykiss	5.8	82	982.126058146130
10/21/2020	Guadalupe Creek	O. mykiss	8.1	83	982.126058146119
10/21/2020	Guadalupe Creek	O. mykiss	10.5	97	982.126058146050
10/21/2020	Guadalupe Creek	O. mykiss	17.5	118	982.126058146061
10/21/2020	Guadalupe Creek	O. mykiss	11.2	99	982.126058146104
10/22/2020	Guadalupe Creek	O. mykiss	4.5	71	982.126058146072
10/28/2020	Stevens Creek	O. mykiss	21	122	982.126058146870
10/28/2020	Stevens Creek	O. mykiss	15.1	105	982.126058146097
10/28/2020	Stevens Creek	O. mykiss	24.2	125	982.126058146872
10/28/2020	Stevens Creek	O. mykiss	34.5	146	982.126058146923
10/28/2020	Stevens Creek	O. mykiss	4.4	68	982.126058146881
10/28/2020	Stevens Creek	O. mykiss	15.6	103	982.126058146902
10/28/2020	Stevens Creek	O. mykiss	48.5	162	900.228000613748
10/28/2020	Stevens Creek	O. mykiss	4.8	70	982.126058146867
10/28/2020	Stevens Creek	O. mykiss	3.8	69	982.126058146909
10/28/2020	Stevens Creek	O. mykiss	4.3	69	982.126058146926
10/28/2020	Stevens Creek	O. mykiss	4.5	69	982.126058146911
10/29/2020	Stevens Creek	O. mykiss	4.6	66	982.126058146903
10/29/2020	Stevens Creek	O. mykiss	4.8	69	982.126058146908
10/29/2020	Stevens Creek	O. mykiss	3.9	68	982.126058146927
10/29/2020	Stevens Creek	O. mykiss	4.1	68	982.126058146919
10/29/2020	Stevens Creek	O. mykiss	3.3	67	982.126058146891
10/29/2020	Stevens Creek	O. mykiss	5.1	71	982.126058146913
10/29/2020	Stevens Creek	O. mykiss	6.1	75	982.126058146914
10/29/2020	Stevens Creek	O. mykiss	4.4	71	982.126058146892
10/29/2020	Stevens Creek	O. mykiss	4.5	69	982.126058146890
10/29/2020	Stevens Creek	O. mykiss	4.4	69	982.126058146861
10/29/2020	Stevens Creek	O. mykiss	6.6	78	982.126058146875
10/29/2020	Stevens Creek	O. mykiss	6.2	78	982.126058146920
10/29/2020	Stevens Creek	O. mykiss	13.1	100	982.126058146874
10/29/2020	Stevens Creek	O. mykiss	4.3	65	982.126058146899
10/29/2020	Stevens Creek	O. mykiss	34.6	141	982.126058146900
10/29/2020	Stevens Creek	O. mykiss	4.2	72	982.126058146858
10/29/2020	Stevens Creek	O. mykiss	8.6	82	982.126058146924
10/29/2020	Stevens Creek	O. mykiss	9.5	88	982.126058146888

10/29/2020	Stevens Creek	O. mykiss	4.9	74	982.126058146922
10/29/2020	Stevens Creek	O. mykiss	4.9	71	982.126058146931
10/29/2020	Stevens Creek	O. mykiss	4.2	70	982.126058146918
10/29/2020	Stevens Creek	O. mykiss	4.4	67	982.126058146925
10/29/2020	Stevens Creek	O. mykiss	4.8	70	982.126058146886
10/29/2020	Stevens Creek	O. mykiss	4.4	71	982.126058146897
10/29/2020	Stevens Creek	O. mykiss	5	71	982.126058146921
10/29/2020	Stevens Creek	O. mykiss	3.7	69	982.126058146928
11/2/2020	Calero Creek	O. mykiss	5.2	74	982.126058146917
11/2/2020	Calero Creek	O. mykiss	7.4	86	982.126058146847
11/2/2020	Calero Creek	O. mykiss	3.7	66	982.126058146876
11/2/2020	Calero Creek	O. mykiss	3.8	68	982.126058146850
11/2/2020	Calero Creek	O. mykiss	8.9	87	982.126058146869
11/2/2020	Calero Creek	O. mykiss	5.1	70	982.126058146859
11/2/2020	Calero Creek	O. mykiss	2.9	66	982.126058146894
11/2/2020	Calero Creek	O. mykiss	5.8	81	982.126058146841
11/2/2020	Calero Creek	O. mykiss	6.2	76	982.1.6058146889
11/2/2020	Calero Creek	O. mykiss	12.9	99	982.126058146860
11/2/2020	Calero Creek	O. mykiss	7.6	86	982.126058146849
11/2/2020	Calero Creek	O. mykiss	4.9	72	982.126058146856
11/2/2020	Calero Creek	O. mykiss	6.5	81	982.126058146845
11/2/2020	Calero Creek	O. mykiss	7.1	84	982.126058146904
11/2/2020	Calero Creek	O. mykiss	11.3	97	982.126058146834
11/2/2020	Calero Creek	O. mykiss	4.6	73	982.126058146863
11/2/2020	Calero Creek	O. mykiss	9.1	90	982.126058146901
11/2/2020	Calero Creek	O. mykiss	11	96	982.126058146896
11/2/2020	Calero Creek	O. mykiss	295.5	290	900.228000613749
11/2/2020	Calero Creek	O. mykiss	3.6	66	982.126058146910
11/2/2020	Calero Creek	O. mykiss	3.9	67	982.126058146871
11/2/2020	Calero Creek	O. mykiss	5.3	75	982.126058146912
11/2/2020	Calero Creek	O. mykiss	4.1	71	982.126058146893
11/2/2020	Calero Creek	O. mykiss	6.7	82	982.126058146833
11/2/2020	Calero Creek	O. mykiss	4.8	71	982.126058146906
11/2/2020	Calero Creek	O. mykiss	4	70	982.126058146915
11/2/2020	Calero Creek	O. mykiss	7.2	81	982.126058146930
11/2/2020	Calero Creek	O. mykiss	8.5	88	982.126058146862
11/2/2020	Calero Creek	O. mykiss	5.7	73	982.126058146884
11/2/2020	Calero Creek	O. mykiss	5.5	79	982.126058146887
11/9/2020	Alamitos Creek	O. mykiss	157.8	239	900.228000613750
11/9/2020	Alamitos Creek	O. mykiss	26.1	133	982.126058146864
11/9/2020	Alamitos Creek	O. mykiss	14.6	94	982.126058146879
11/9/2020	Alamitos Creek	O. mykiss	16.5	103	982.126058146898
11/9/2020	Alamitos Creek	O. mykiss	19.4	106	982.126058146873
11/9/2020	Alamitos Creek	O. mykiss	16.2	111	982.126058146851
11/9/2020	Alamitos Creek	O. mykiss	162.5	240	900.228000613752
11/9/2020	Alamitos Creek	O. mykiss	80	192	900.228000613751
11/9/2020	Alamitos Creek	O. mykiss	25.8	125	982.126058146929
11/9/2020	Alamitos Creek	O. mykiss	27.8	138	982.126058146854

11/9/2020	Alamitos Creek	O. mykiss	9.8	95	982.126058146857
11/10/2020	Alamitos Creek	O. mykiss	19.7	123	982.126058146838
11/10/2020	Alamitos Creek	O. mykiss	6.6	79	982.126058146832
11/10/2020	Alamitos Creek	O. mykiss	15.4	117	982.126058146916
11/10/2020	Alamitos Creek	O. mykiss	23.1	132	982.126058146852
11/10/2020	Alamitos Creek	O. mykiss	25.9	136	982.126058146868
11/12/2020	Alamitos Creek	O. mykiss	29.7	135	982.126058146853
11/12/2020	Alamitos Creek	O. mykiss	23.7	129	982.126058146839
11/12/2020	Alamitos Creek	O. mykiss	9.8	90	982.126058146843
11/12/2020	Alamitos Creek	O. mykiss	20.1	113	982.126058146877
11/12/2020	Alamitos Creek	O. mykiss	31.5	133	982.126058146836
11/12/2020	Alamitos Creek	O. mykiss	18.4	110	982.126058146878
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10/18/2021	Calero Creek	O. mykiss	9.4	85	982.126059706529
10/18/2021	Calero Creek	O. mykiss	6.1	77	982.126059709101
10/18/2021	Calero Creek	O. mykiss	4.6	66	982.126059706512
10/18/2021	Calero Creek	O. mykiss	6.9	74	982.126059709081
10/18/2021	Calero Creek	O. mykiss	4.9	71	982.126059709092
10/18/2021	Calero Creek	O. mykiss	6.8	79	982.126059706527
10/18/2021	Calero Creek	O. mykiss	81.5	182	900.228000613810
10/18/2021	Calero Creek	O. mykiss	4.5	65	982.126059706531
10/18/2021	Calero Creek	O. mykiss	3.4	65	982.126059706553
10/18/2021	Calero Creek	O. mykiss	4.3	69	982.126059706549
10/18/2021	Calero Creek	O. mykiss	3.8	68	982.126059706576
10/18/2021	Calero Creek	O. mykiss	3.6	65	982.126059706577
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10/18/2021	Calero Creek	O. mykiss	5.7	74	982.126059706523
10/18/2021	Calero Creek	O. mykiss	10.9	89	982.126059709078
10/18/2021	Calero Creek	O. mykiss	7.8	84	982.126059709103
10/18/2021	Calero Creek	O. mykiss	7.5	84	982.126059706551
10/18/2021	Calero Creek	O. mykiss	8.4	85	982.126059709108
10/18/2021	Calero Creek	O. mykiss	5.4	72	982.126059706561
10/18/2021	Calero Creek	O. mykiss	5.1	70	982.126059706544
10/18/2021	Calero Creek	O. mykiss	6.7	78	982.126059709107
10/18/2021	Calero Creek	O. mykiss	11.4	95	982.126059709088
10/28/2021	Alamitos Creek	O. mykiss	5.1	75	982.126059706552
10/29/2021	Alamitos Creek	O. mykiss	5	75	982.126059706554
10/29/2021	Alamitos Creek	O. mykiss	8.2	84	982.126059709079
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11/1/2021	Coyote Creek	O. mykiss	43.4	151	900.228000613754
11/1/2021	Coyote Creek	O. mykiss	25.2	126	982.126059706573
11/1/2021	Coyote Creek	O. mykiss	11.9	101	982.126059706540
11/1/2021	Coyote Creek	O. mykiss	13.7	99	982.126059706520
11/1/2021	Coyote Creek	O. mykiss	11.4	97	982.126059706563
11/1/2021	Coyote Creek	O. mykiss	8.9	86	982.126059709085
11/2/2021	Coyote Creek	O. mykiss	30.4	139	982.126059706568

11/2/2021	Coyote Creek	O. mykiss	24.2	129	982.126059709100
11/2/2021	Coyote Creek	O. mykiss	28.7	132	982.126059706511
11/2/2021	Coyote Creek	O. mykiss	17.5	115	982.126059706557
11/2/2021	Coyote Creek	O. mykiss	26.9	129	982.126059709087
11/2/2021	Coyote Creek	O. mykiss	26.7	124	982.126059706516
11/2/2021	Coyote Creek	O. mykiss	21.7	119	982.126059706567
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11/2/2021	Coyote Creek	O. mykiss	21.1	119	982.126059706569
11/2/2021	Coyote Creek	O. mykiss	12.8	98	982.126059706538
11/2/2021	Coyote Creek	O. mykiss	16.3	105	982.126059706550
11/2/2021	Coyote Creek	O. mykiss	21.4	118	982.126059709095
11/2/2021	Coyote Creek	O. mykiss	19.8	110	982.126059706560
11/2/2021	Coyote Creek	O. mykiss	27.1	125	982.126059709089
11/2/2021	Coyote Creek	O. mykiss	18.5	113	982.126059709083
11/2/2021	Coyote Creek	O. mykiss	23.1	125	982.126059709096
11/3/2021	Coyote Creek	O. mykiss	28.4	131	982.126059706537
11/3/2021	Coyote Creek	O. mykiss	34.2	140	982.126059709094
11/3/2021	Coyote Creek	O. mykiss	14.8	104	982.126059706526
11/3/2021	Coyote Creek	O. mykiss	19.6	115	982.126059706566
11/3/2021	Coyote Creek	O. mykiss	36.9	147	982.126059709106
11/3/2021	Coyote Creek	O. mykiss	32.5	141	982.126059706564
11/3/2021	Coyote Creek	O. mykiss	17.5	116	982.126059706519
11/3/2021	Coyote Creek	O. mykiss	11.9	99	982.126059706562
11/3/2021	Coyote Creek	O. mykiss	37.8	148	982.126059706545
11/3/2021	Coyote Creek	O. mykiss	28.0	134	982.126059709084
11/3/2021	Coyote Creek	O. mykiss	15.4	103	982.126059706572
11/3/2021	Coyote Creek	O. mykiss	17.3	112	982.126059709098
11/3/2021	Coyote Creek	O. mykiss	28.4	132	982.126059709093
11/3/2021	Coyote Creek	O. mykiss	29.5	135	982.126059706547
11/3/2021	Coyote Creek	O. mykiss	43.7	150	900.228000613813
11/3/2021	Coyote Creek	O. mykiss	23.6	126	982.126059709086
11/3/2021	Coyote Creek	O. mykiss	21.2	117	982.126059706528
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11/3/2021	Coyote Creek	O. mykiss	19.9	114	982.126059706515
11/3/2021	Coyote Creek	O. mykiss	-	151	900.228000613814
11/3/2021	Coyote Creek	O. mykiss	418	320	900.228000613816
11/3/2021	Coyote Creek	O. mykiss	26.7	127	982.126059706534
11/3/2021	Coyote Creek	O. mykiss	132.3	252	900.228000613815
11/3/2021	Coyote Creek	O. mykiss	14.0	104	982.126059706574
11/4/2021	Guadalupe Creek	O. mykiss	18.8	120	982.126059706522
11/4/2021	Guadalupe Creek	O. mykiss	5.8	78	982.126059706524
11/4/2021	Guadalupe Creek	O. mykiss	7.6	81	982.126059709109
11/4/2021	Guadalupe Creek	O. mykiss	6.1	81	982.126058146865
11/4/2021	Guadalupe Creek	O. mykiss	22.6	126	982.126058146880
11/4/2021	Guadalupe Creek	O. mykiss	52.8	171	900.228000613899
11/8/2021	Stevens Creek	O. mykiss	95.1	198	900.228000613898
11/8/2021	Stevens Creek	O. mykiss	11.6	95	982.126058146835

11/8/2021	Stevens Creek	O. mykiss	114	207	982.126058146870
11/8/2021	Stevens Creek	O. mykiss	11.2	96	982.126058146885

Guadalupe River 2020-2021 Adult Salmonid Migration Monitoring Using the Vaki Riverwatcher Passive Monitoring System at the Alamitos Drop Structure

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January 2022

Contents

Introduction 1
Methods 2
  Installation, Operation, and Maintenance 2
  Data Analysis 6
Results 7
Discussion 10
References 11

Tables

Table 1. Confidence rating system used for identifying Vaki detections of anadromous fish species 7
Table 2. Non-anadromous fish species positively identified by the Guadalupe River Vaki during the 2020-2021 monitoring season 8

Figures

Figure 1. Guadalupe River Vaki Riverwatcher location 3
Figure 2. Installation of the Vaki Riverwatcher system in the Alamitos Fishway on September 29, 2020. The red box indicates the fish counter 4
Figure 3. Vaki Riverwatcher fish counter 5
Figure 4. *O. mykiss* detections in relation to stream flow (cubic feet per second, shown on a logarithmic scale) on the Guadalupe River at Stream Gage ALERT 5023b above Almaden Expressway 9

Appendices

Appendix A: Example Silhouettes and Video Images

Introduction

Steelhead (*Oncorhynchus mykiss*) in the Central California Coast (CCC) Distinct Population Segment (DPS) were listed as threatened by the National Marine Fisheries Service (NMFS) in 1997. Due to their protected status, the Santa Clara Valley Water District (Valley Water) implemented a noninvasive means of documenting adult steelhead escapement through the Alamitos Fishway on the Guadalupe River using the Vaki Riverwatcher System (Vaki). The Vaki is a computer-based fish counter that employs in-channel scanner plates and a digital camera to passively capture videos and silhouette images of fish as they pass between the plates along their normal migration route. The Vaki provides information on the occurrence and timing of adult fish migration both upstream and downstream as individuals move through the counter. This monitoring also allows for detections of other anadromous fish such as Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Pacific lamprey (*Entosphenus tridentatus*).

The Guadalupe River Vaki unit has been operated within the Alamitos Fishway (also referred to as fish ladder) during the anadromous salmonid migration period (typically considered to be October to May) for seven monitoring seasons. The fish ladder was installed in November 1999 at the Alamitos drop structure; this 4-meter-tall structure had previously created an impassable barrier to fish migration. The installation of the Alamitos Fishway opened up an additional 27 kilometers of upstream habitat for migrating fish, and the Vaki was first deployed in the most downstream weir of the Alamitos Fishway for three monitoring seasons from 2003 to 2006 to document fish use of the ladder. In 2018, the Vaki was reinstalled at the Alamitos Fishway for a fourth season of monitoring following a 12-year break at this location, then for a fifth season in 2018-2019, and a sixth in 2019-2020.

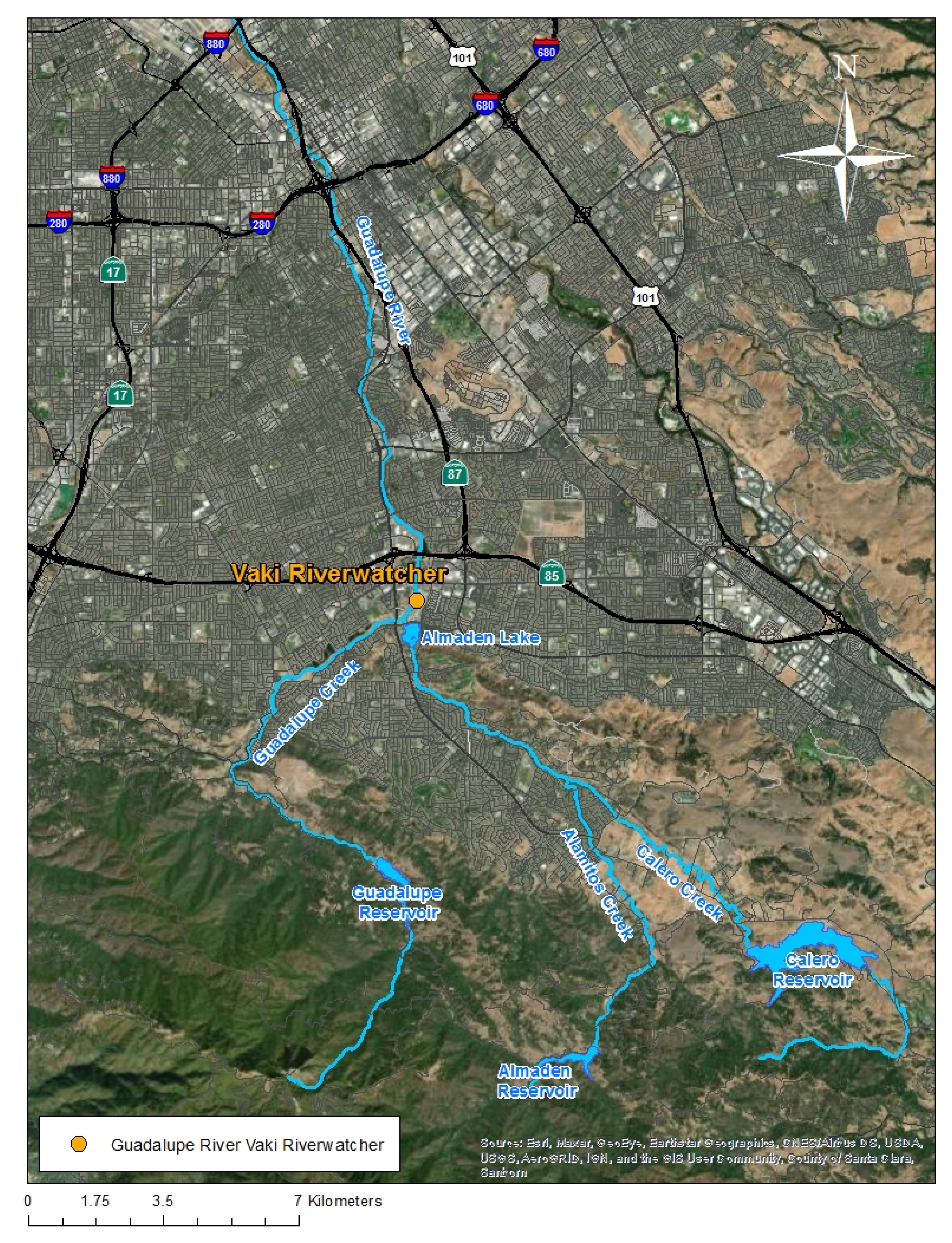
In the fall of 2020, the Vaki was installed for a seventh season of monitoring, which is the focus of this report.

Methods

Installation, Operation, and Maintenance

The fish ladder is located 32 kilometers upstream of the South San Francisco Bay on the Guadalupe River between Coleman Road and Blossom Hill Road, just downstream of Almaden Lake in San Jose, California (Figure 1). For the 2020-2021 season, the Guadalupe River Vaki was installed in the fish ladder on September 29, 2020 (Figure 2); however, the Vaki was not lowered into the fish ladder and turned on until November 16, 2020. Due to extreme drought, the Guadalupe River had dried back downstream of the Vaki in 2020, preventing fish passage, and only once flows increased and connectivity was restored was the Vaki turned on for the season.

The counter itself is a rectangular-shaped unit outfitted with scanner plates, a camera, and infrared light-emitting diodes on the interior (Figure 3) and is completely submerged underwater within the fish ladder. Adult fish were directed through the counter opening by use of weirs in the ladder. When a fish swims through the counter and breaks the plane of light beams, the fish is scanned and a resulting silhouette image is sent to the onsite computer. Other information recorded during each detection includes the speed the fish was traveling, the direction the fish was moving (upstream or downstream), body depth (for estimating length based on length-to-depth ratios from the literature), along with the date and time of the detection, and water temperature. A detection also triggers a digital camera that records a 4.1-second video for fish traveling upstream and a 14.4-second video for fish traveling downstream. Because debris or organisms in the channel can trigger detections, the videos are used to confirm the presence of a fish as well as improve confidence in species identification.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, County of Santa Clara, Sanborn

Figure 1. Guadalupe River Vaki Riverwatcher location.

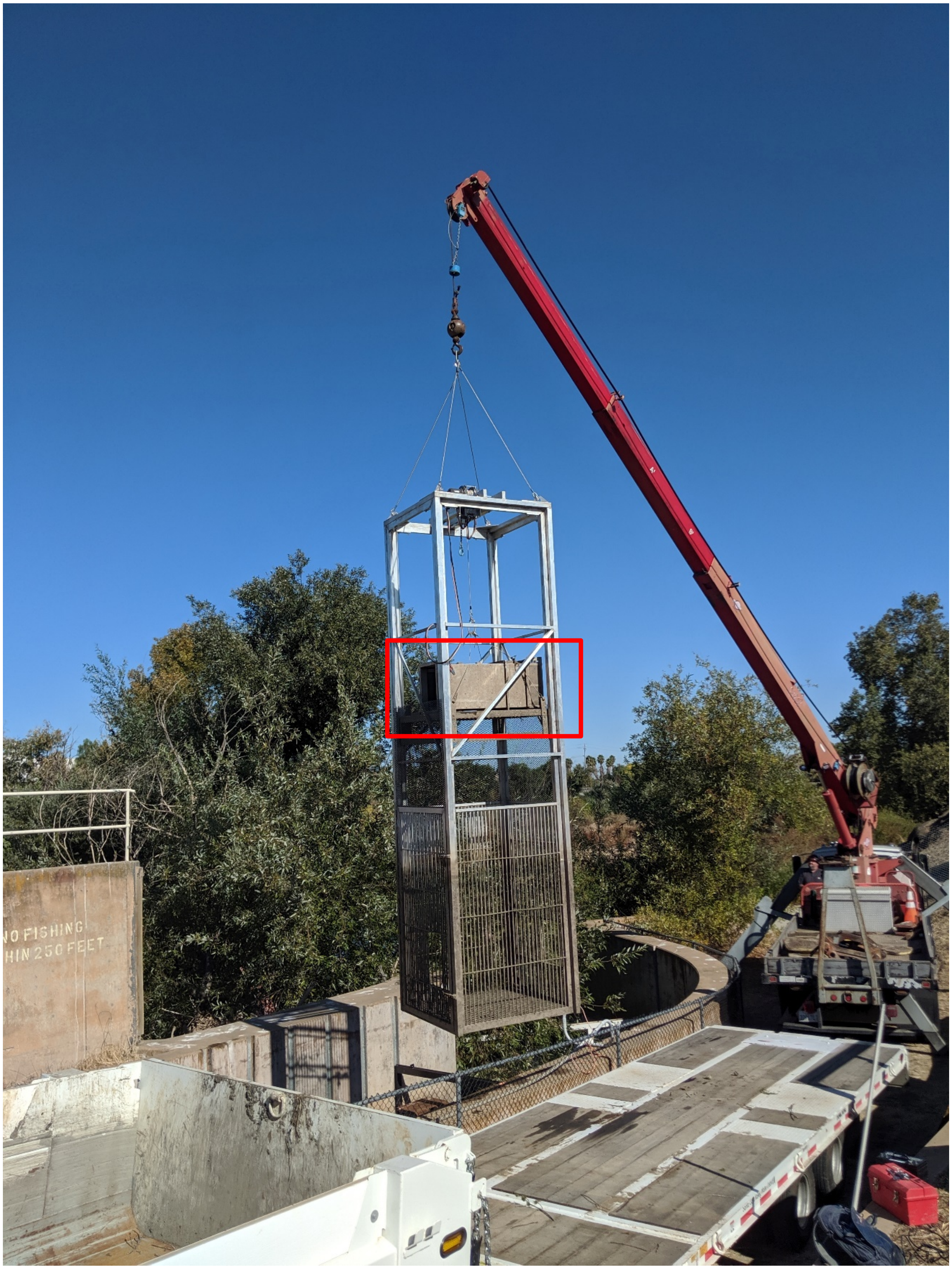


Figure 2. Installation of the Vaki Riverwatcher system in the Alamitos Fishway on September 29, 2020. The red box indicates the fish counter.

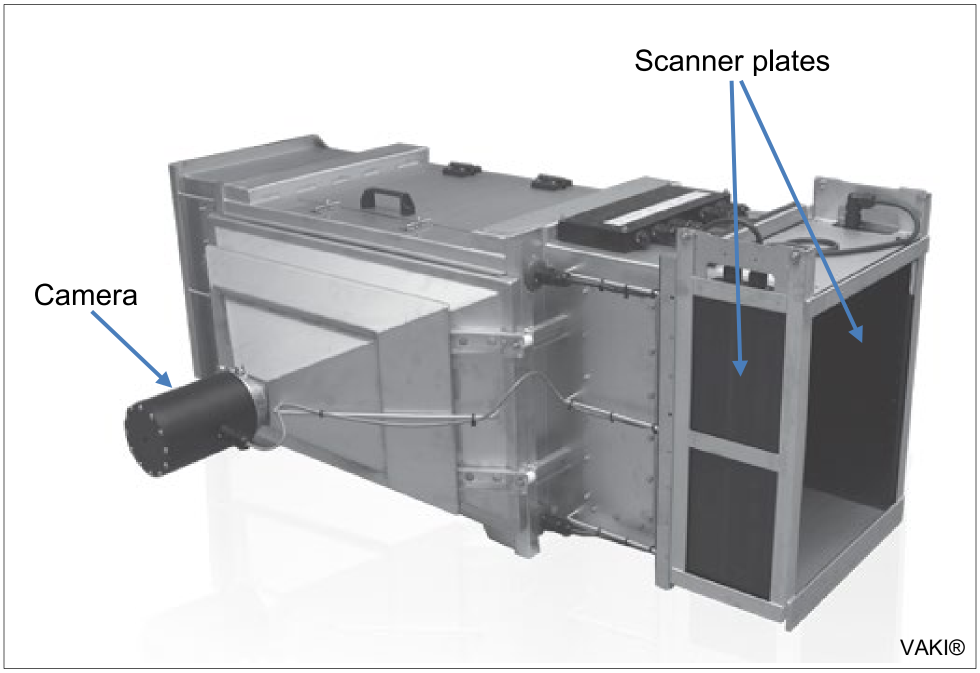


Figure 3. Vaki Riverwatcher fish counter.

All data collected by the Vaki were stored on the attached onsite computer. Data were manually downloaded from the computer weekly and transferred to the Valley Water network. Each time the data were downloaded, the onsite computer database was reset. The files were vetted by Valley Water staff as soon as possible following the data download. This includes manually going through each of the silhouette images and videos to identify fish by species or note a false fish detection. During the weekly field visits to download data, Valley Water staff also performed maintenance by cleaning debris and algal build-up on the scanner plates and plexiglass in front of the camera with a Mr. Long Arm® brush.

The Vaki was powered by four 6-volt batteries that were charged by a solar panel. On a few occasions after cloudy and rainy days, the battery reserve dropped so low that the Vaki would only record a silhouette image for each detection with no accompanying video. In these instances, fish were identified solely based on the silhouette image, when possible. No complete power outages occurred during the monitoring period.

In previous years, the Vaki was checked twice a week; however, due to the COVID-19 pandemic, Valley Water staff reduced the number of checks to once per week for the 2020-2021 season. Masks were worn and social distancing guidelines were adhered to during site visits.

Due to continuing extreme drought conditions, portions of the Guadalupe River experienced dry backs in April after connectivity was briefly established during winter storms. The Vaki was powered off for the season on April 19, 2021, as fish migration was not possible.

Data Analysis

The Vaki recorded silhouettes and videos of all items large enough to break the plane of the diodes (body depth of 40 mm or greater). Scanned infrared silhouettes and video images were manually reviewed using the Winari software to ensure that only fish passage events were included in the overall passage counts. Videos were used to identify fish to species when river conditions provided clear images, and silhouettes were also used to identify fish to species if identifying characteristics were present. Detections without accompanying videos were only sorted into specific species categories if the silhouette was clear and the confidence level of identification was high; otherwise, these detections were sorted into the “unknown fish” category. Videos with two or more species present were placed into the “multiple species” category, unless one of the species detected was an anadromous fish; in these cases, the detection was recorded as the species of anadromous fish identified. A confidence level rating system analyzing both silhouette and video quality was used to rate the likelihood of accurate identification for anadromous fish (Table 1). During the 2020-2021 monitoring period, this rating system was used for *O. mykiss* only, as this was the only anadromous species detected by the Vaki.

Table 1. Confidence rating system used for identifying Vaki detections of anadromous fish species.

	High quality video	**Average quality video**	**Poor quality video**	**Video absent**
High quality silhouette	High confidence	High confidence	Medium confidence	Medium confidence
Average quality silhouette	High confidence	High confidence	Medium confidence	Low confidence
Poor quality silhouette	High confidence	Medium confidence	Low confidence	Can’t be categorized
Silhouette absent	High confidence	Medium confidence	Low confidence	N/A

Length-to-depth ratios were used to estimate the length of a specific individual based on their body depth as recorded by the Vaki. The length-to-depth ratios for *O. mykiss* were 4.1:1 for small fish (up to 400 mm fork-length) and 4.8:1 for medium and large fish (401 to 1000 mm fork-length) (Cuthbert et al. 2013).

The Vaki system is designed to track adult migratory fish with a clear migratory path (i.e., anadromous fish), but it does not provide the ability to estimate the number of non-anadromous fish using the habitat in which the system is installed. For Centrarchidae, Cyprinidae, and Catostomidae species that are not migrating, detection indicates presence but cannot be used to assess population numbers. These species were amalgamated by family for analysis and reporting purposes, but the species name was noted if positive identification was possible.

Results

A total of 3,560 fish detections were recorded during the 2020-2021 monitoring season. Non-anadromous fish in the Catostomidae, Centrarchidae, Cyprinidae, and Cottidae families accounted for 2,771 of the detections, and 783 detections were placed in the unknown fish category. These groups combined accounted for 3,554 (99.83%) of the total number of Vaki fish detections.

The non-anadromous fish species positively identified by the Vaki for each family are recorded in Table 2. Examples of positive species identifications can be seen in Appendix A.

Table 2. Non-anadromous fish species positively identified by the Guadalupe River Vaki during the 2020-2021 monitoring season.

Family	**Species**	**Native**	**Percent of Fish Detections (%)**
Catostomidae	Sacramento sucker (*Catostomus occidentalis*)	Yes	2.75
Centrarchidae	Largemouth bass (*Micropterus salmoides*)	No	0.11
Cyprinidae	Common carp (*Cyprinus carpio*)	No	74.63
Cottidae	Prickly sculpin (*Cottus asper*)	Yes	0.03

No Chinook salmon or Pacific lamprey were identified during the 2020-2021 monitoring season. *O. mykiss* was the only anadromous fish species identified with a total of six detections (accounting for 0.17% of Vaki fish detections), five of which occurred on January 30, 2021. The remaining detection was recorded on April 14, 2021. Three of the *O. mykiss* detections were recorded moving downstream and three were recorded moving upstream; however, the same fish may have been recorded going both up and downstream. Using the confidence matrix (Table 1), four of the *O. mykiss* Vaki detections were rated high confidence (high or average quality video and silhouette) and two were rated medium confidence (average quality video and average or poor quality silhouette). Based on body depth comparisons and proximity in timing, it was determined that three individual *O. mykiss* passed through the Vaki. The estimated sizes of *O. mykiss* detected were 172 mm, 283 mm, and 374 mm based on length-to-depth ratios. One detection was classified as an *O. mykiss* in the adult steelhead size range (>350 mm) and was recorded moving downstream, while the remaining detections were in the juvenile size range (≤350 mm). The timing of the *O. mykiss* detections in relation to stream flow on the Guadalupe River can be seen in Figure 4.

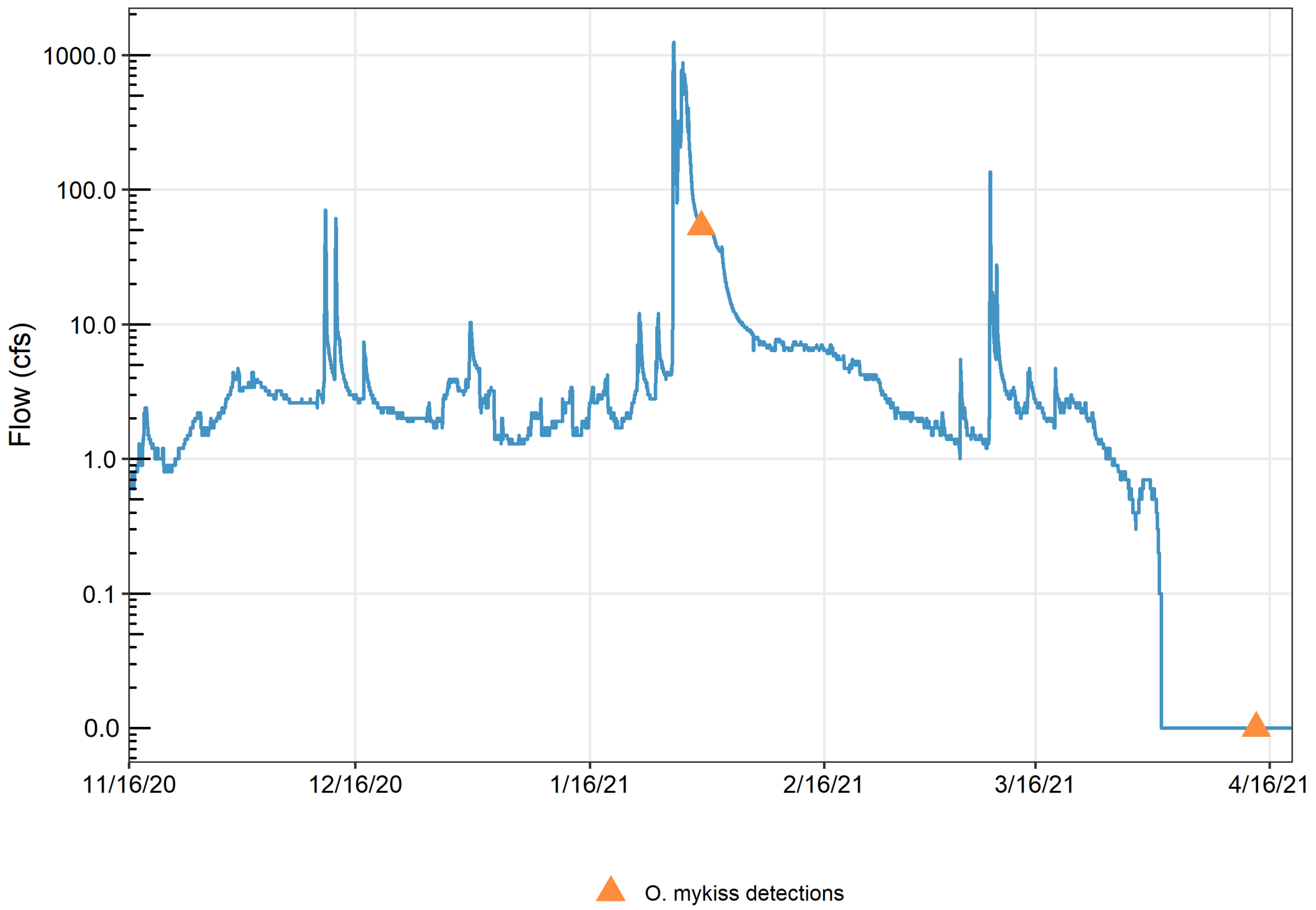


Figure 4. *O. mykiss* detections in relation to stream flow (cubic feet per second, shown on a logarithmic scale) on the Guadalupe River at Stream Gage ALERT 5023b above Almaden Expressway. Note that the stream gage is not located at the fish ladder and is therefore not an exact depiction of ladder conditions (e.g., though flow dropped to 0 cfs at the stream gage, there was still flow present at the ladder). Also note that multiple *O. mykiss* detections occurred on January 30th and the individual detections cannot be discerned on the graph.

Discussion

No Pacific lamprey or Chinook salmon detections occurred during the 2020-2021 Vaki monitoring period. Per Moyle (2002), the Chinook salmon migration season takes place from October through January, and though the Vaki was not operational until November 16th, passage was not available for Chinook salmon to access the upper portions of the watershed due to the dry back downstream. An adult Chinook salmon was visually observed moving upstream on the mainstem Guadalupe River on November 19th during the 2020 fall juvenile rearing sampling (Valley Water 2021). The fish was seen under the St. John Street bridge in downtown San Jose, approximately six miles downstream of the Alamitos fish ladder and the Guadalupe River Vaki. Spawning habitat is available in this reach and the Los Gatos Creek tributary had passage opportunities. Aside from two flow events that occurred in the beginning of December (approximately 75 cfs) and end of January (approximately 1250 cfs), stream flows were generally low to nonexistent during the 2020-2021 Chinook salmon migration season, reducing the opportunity for upstream movement.

No adult-sized *O. mykiss* were observed moving upstream through the Vaki during the monitoring period. Only one adult-sized *O. mykiss* was identified in January with an estimated length of 374 mm and was recorded traveling downstream. It is likely that this was a resident rainbow trout moving through the system after the large flow event that occurred at the end of January. According to Moyle (2002) and Smith and Leicester (2016) growth rates, the juvenile *O. mykiss* detected in January and April were likely in their third and second year, respectively, based on their estimated lengths (283 mm and 172 mm). There is the potential that more adult *O. mykiss* actually were detected swimming through the Vaki but were placed in the unknown fish category because the video or silhouette was not clear enough for positive identification.

The Vaki Riverwatcher is not designed to track the movement of young juvenile *O. mykiss*, which may have gone unidentified during the monitoring season. Their small size allows them to potentially swim through the weir bars outside of the Vaki or swim through the scanner plates without triggering the diodes, thus avoiding detection.

Overall, the 2020-2021 Vaki monitoring season had limited precipitation and limited stream flow, reducing opportunity for upstream passage of both adult *O. mykiss* and Chinook salmon.

References

Cuthbert, R., Cuthbert, P., and Fuller, A. 2013. Salinas River Basin Adult Steelhead Escapement Monitoring: 2013 Annual Report-Final Draft. Submitted to the Monterey County Water Resources Agency. FISHBIO, Oakdale, California.

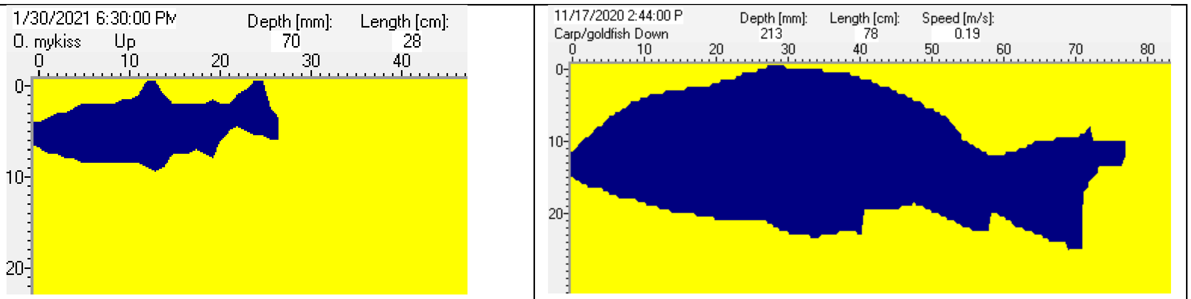
Moyle, P. B. 2002. *Inland fishes of California*. Berkeley: University of California Press.

Smith and Leicester. 2016. Guadalupe Creek Fish Sampling in October 2015 and 2016. California Department of Fish and Wildlife and San Jose State University.

Valley Water. 2021. 2020 Juvenile *Onchorhynchus mykiss* Rearing Monitoring in the Guadalupe River Watershed. Prepared by the Environmental Mitigation and Monitoring Unit. San Jose, CA.

Appendix A

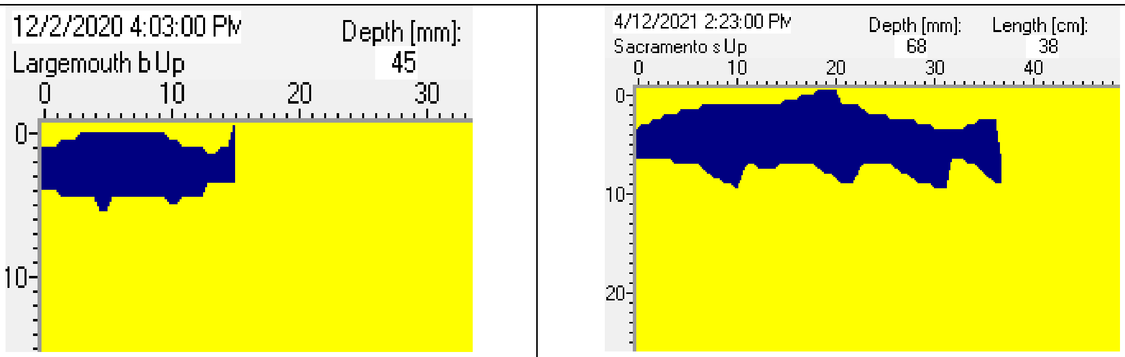
Example Silhouettes and Video Images


1/30/2021 6:30:00 PM
O. mykiss Up
Depth [mm]: 70
Length [cm]: 28

11/17/2020 2:44:00 P
Carp/goldfish Down
Depth [mm]: 213
Length [cm]: 78
Speed [m/s]: 0.19

Oncorhynchus mykiss

Common carp

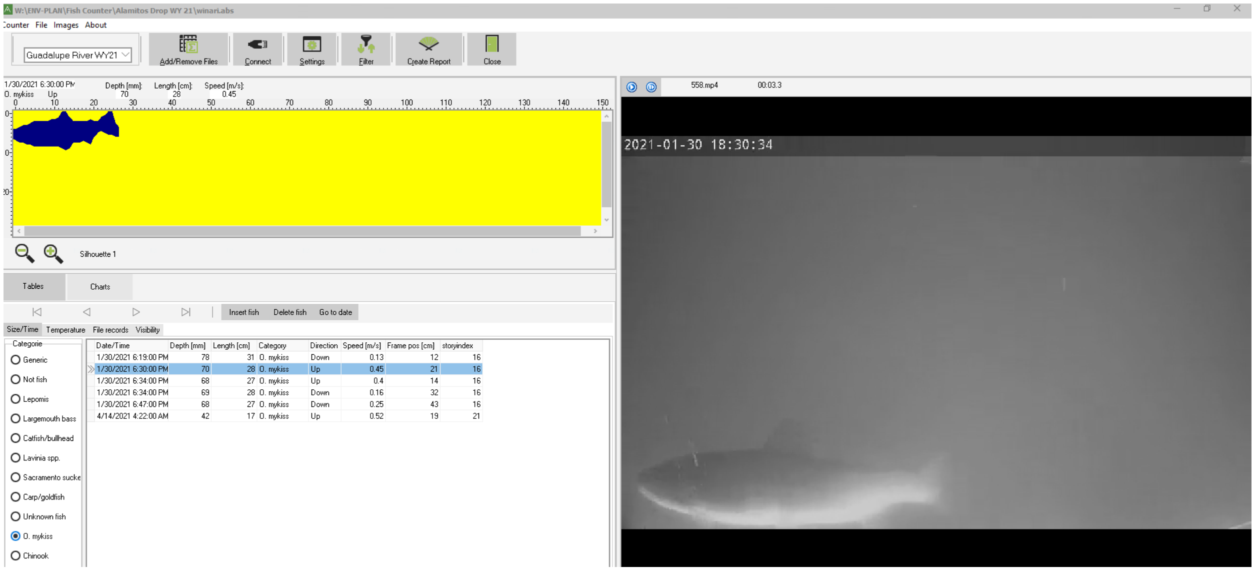

12/2/2020 4:03:00 PM
Largemouth b Up
Depth [mm]: 45

4/12/2021 2:23:00 PM
Sacramento s Up
Depth [mm]: 68
Length [cm]: 38

Largemouth bass

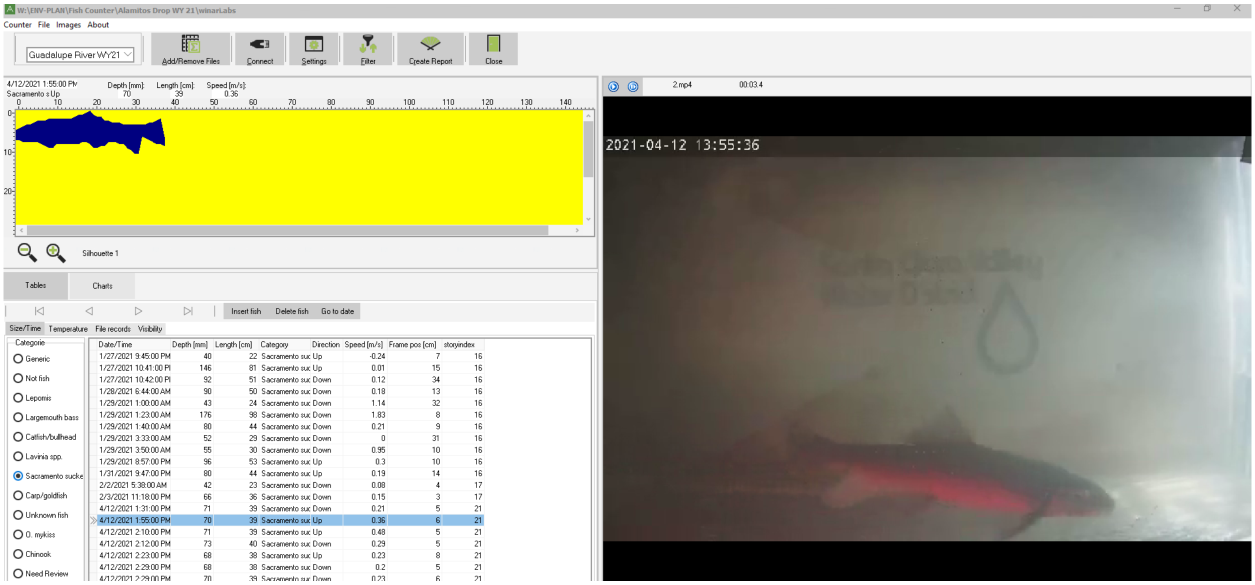
Sacramento sucker

Figure A-1. Examples of silhouette images generated by the Vaki for each fish species referenced in the report. A silhouette representative of the prickly sculpin (*Cottus asper*) was not available; this species was identified based on the video.



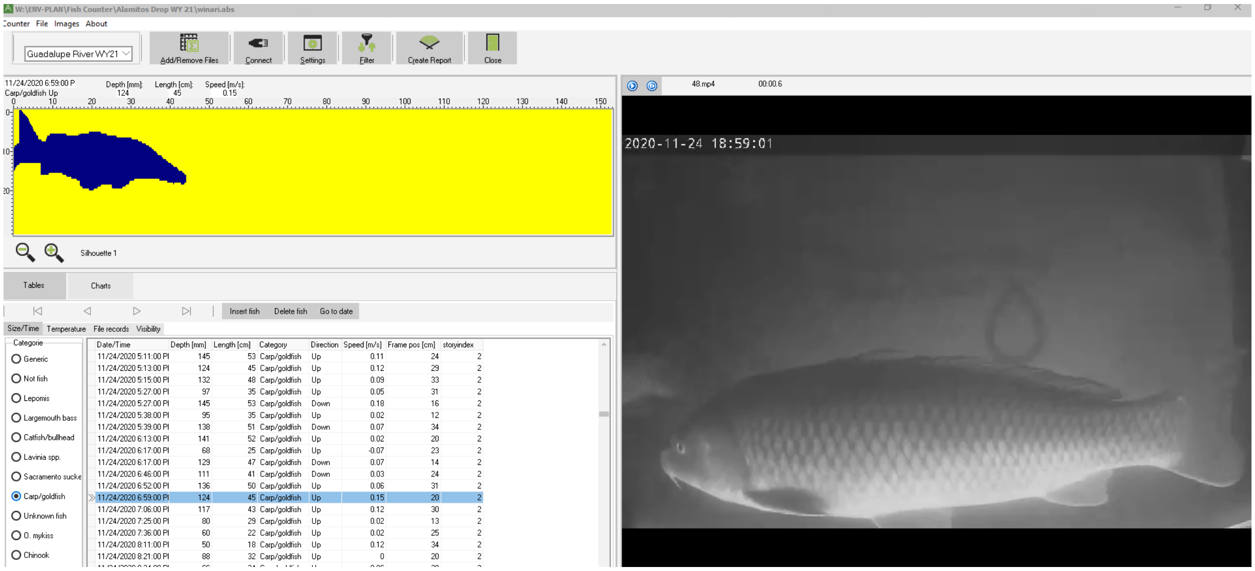
Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
1/30/2021 6:19:00 PM	78	31	O. mykiss	Down	0.13	12	16
1/30/2021 6:30:00 PM	70	28	O. mykiss	Up	0.45	21	16
1/30/2021 6:34:00 PM	68	27	O. mykiss	Up	0.4	14	16
1/30/2021 6:34:00 PM	69	28	O. mykiss	Down	0.16	32	16
1/30/2021 6:47:00 PM	68	27	O. mykiss	Down	0.25	43	16
4/14/2021 4:22:00 AM	42	17	O. mykiss	Up	0.52	19	21

Figure A-2. Vaki video image and silhouette of an *Oncorhynchus mykiss*.



Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
1/27/2021 9:45:00 PM	40	22	Sacramento suc	Up	-0.24	7	16
1/27/2021 10:41:00 PI	146	81	Sacramento suc	Up	0.01	15	16
1/27/2021 10:42:00 PI	92	51	Sacramento suc	Down	0.12	34	16
1/28/2021 6:44:00 AM	90	50	Sacramento suc	Down	0.18	13	16
1/29/2021 1:00:00 AM	43	24	Sacramento suc	Down	1.14	32	16
1/29/2021 1:23:00 AM	176	98	Sacramento suc	Down	1.83	8	16
1/29/2021 1:40:00 AM	80	44	Sacramento suc	Down	0.21	9	16
1/29/2021 3:33:00 AM	52	29	Sacramento suc	Down	0	31	16
1/29/2021 3:50:00 AM	55	30	Sacramento suc	Down	0.95	10	16
1/29/2021 8:57:00 PM	96	53	Sacramento suc	Up	0.3	10	16
1/31/2021 9:47:00 PM	80	44	Sacramento suc	Up	0.19	14	16
2/2/2021 5:38:00 AM	42	23	Sacramento suc	Down	0.08	4	17
2/3/2021 11:18:00 PM	66	36	Sacramento suc	Down	0.15	3	17
4/12/2021 1:31:00 PM	71	39	Sacramento suc	Down	0.21	5	21
4/12/2021 1:55:00 PM	70	39	Sacramento suc	Up	0.36	6	21
4/12/2021 2:10:00 PM	71	39	Sacramento suc	Up	0.48	5	21
4/12/2021 2:12:00 PM	73	40	Sacramento suc	Down	0.29	5	21
4/12/2021 2:23:00 PM	68	38	Sacramento suc	Up	0.23	8	21
4/12/2021 2:29:00 PM	68	38	Sacramento suc	Down	0.2	5	21
4/12/2021 2:29:00 PM	70	39	Sacramento suc	Down	0.23	6	21

Figure A-3. Vaki video image and silhouette of a Sacramento sucker (*Catostomus occidentalis*).

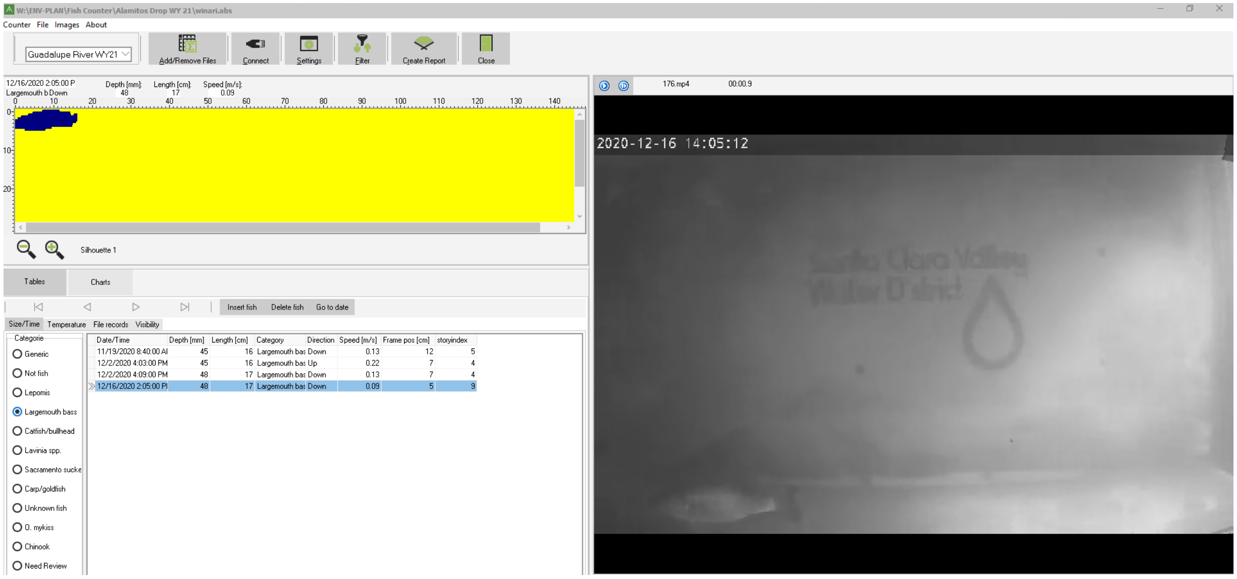


11/24/2020 6:59:00 P
Carp/goldfish Up

Depth [mm]: 124
Length [cm]: 45
Speed [m/s]: 0.15

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
11/24/2020 5:11:00 PI	145	53	Carp/goldfish	Up	0.11	24	2
11/24/2020 5:13:00 PI	124	45	Carp/goldfish	Up	0.12	29	2
11/24/2020 5:15:00 PI	132	48	Carp/goldfish	Up	0.09	33	2
11/24/2020 5:27:00 PI	97	35	Carp/goldfish	Up	0.05	31	2
11/24/2020 5:27:00 PI	145	53	Carp/goldfish	Down	0.18	16	2
11/24/2020 5:38:00 PI	95	35	Carp/goldfish	Up	0.02	12	2
11/24/2020 5:39:00 PI	138	51	Carp/goldfish	Down	0.07	34	2
11/24/2020 6:13:00 PI	141	52	Carp/goldfish	Up	0.02	20	2
11/24/2020 6:17:00 PI	68	25	Carp/goldfish	Up	-0.07	23	2
11/24/2020 6:17:00 PI	129	47	Carp/goldfish	Down	0.07	14	2
11/24/2020 6:46:00 PI	111	41	Carp/goldfish	Down	0.03	24	2
11/24/2020 6:52:00 PI	136	50	Carp/goldfish	Up	0.06	31	2
11/24/2020 6:59:00 PI	124	45	Carp/goldfish	Up	0.15	20	2
11/24/2020 7:06:00 PI	117	43	Carp/goldfish	Up	0.12	30	2
11/24/2020 7:25:00 PI	80	29	Carp/goldfish	Up	0.02	13	2
11/24/2020 7:36:00 PI	60	22	Carp/goldfish	Up	0.02	25	2
11/24/2020 8:11:00 PI	50	18	Carp/goldfish	Up	0.12	34	2
11/24/2020 8:21:00 PI	88	32	Carp/goldfish	Up	0	20	2

Figure A-4. Vaki video image and silhouette of a common carp (*Cyprinus carpio*).

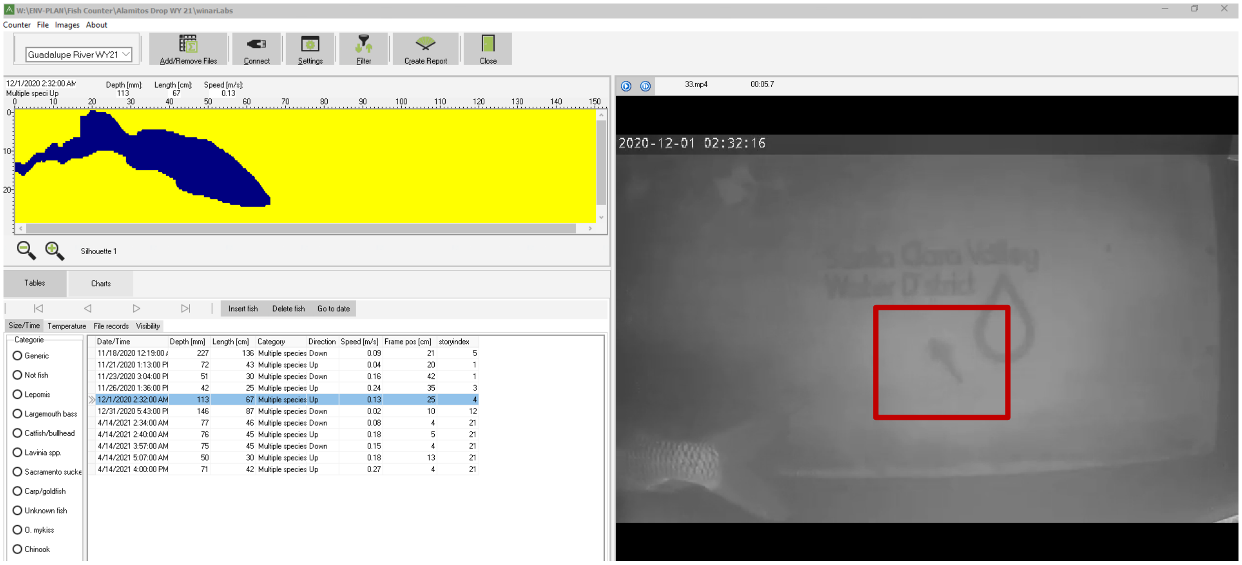


12/16/2020 2:05:00 P
Largemouth b Down

Depth [mm]: 48
Length [cm]: 17
Speed [m/s]: 0.09

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
11/19/2020 8:40:00 AI	45	16	Largemouth bas	Down	0.13	12	5
12/2/2020 4:03:00 PM	45	16	Largemouth bas	Up	0.22	7	4
12/2/2020 4:09:00 PM	48	17	Largemouth bas	Down	0.13	7	4
12/16/2020 2:05:00 PI	48	17	Largemouth bas	Down	0.09	5	9

Figure A-5. Vaki video image and silhouette of a largemouth bass (*Micropterus salmoides*).



12/1/2020 2:32:00 AM
Multiple speci Up

Depth [mm]: 113
Length [cm]: 67
Speed [m/s]: 0.13

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
11/18/2020 12:19:00 A	227	136	Multiple species	Down	0.09	21	5
11/21/2020 1:13:00 PI	72	43	Multiple species	Up	0.04	20	1
11/23/2020 3:04:00 PI	51	30	Multiple species	Down	0.16	42	1
11/26/2020 1:36:00 PI	42	25	Multiple species	Up	0.24	35	3
12/1/2020 2:32:00 AM	113	67	Multiple species	Up	0.13	25	4
12/31/2020 5:43:00 PI	146	87	Multiple species	Down	0.02	10	12
4/14/2021 2:34:00 AM	77	46	Multiple species	Down	0.08	4	21
4/14/2021 2:40:00 AM	76	45	Multiple species	Up	0.18	5	21
4/14/2021 3:57:00 AM	75	45	Multiple species	Down	0.15	4	21
4/14/2021 5:07:00 AM	50	30	Multiple species	Up	0.18	13	21
4/14/2021 4:00:00 PM	71	42	Multiple species	Up	0.27	4	21

Figure A-6. Vaki video image of a prickly sculpin (*Cottus asper*). The fish is indicated by the red square. Note that a common carp is also present in the bottom left corner of the video; this video was therefore placed into the “multiple species” category.